

Consulting Engineer



December 1960

CRAIG P. HAZELET, of Louisville, Kentucky, is a senior partner of Hazelet & Erdal, which has offices in Louisville, Chicago, Cincinnati, and Lansing. As immediate past chairman of the American Society of Civil Engineers' Committee on Professional Conduct, Hazelet does not believe that it is the function of an ethics policing group "to ride the country as headsman tracking down members who might be cited for violating the Code of Ethics."

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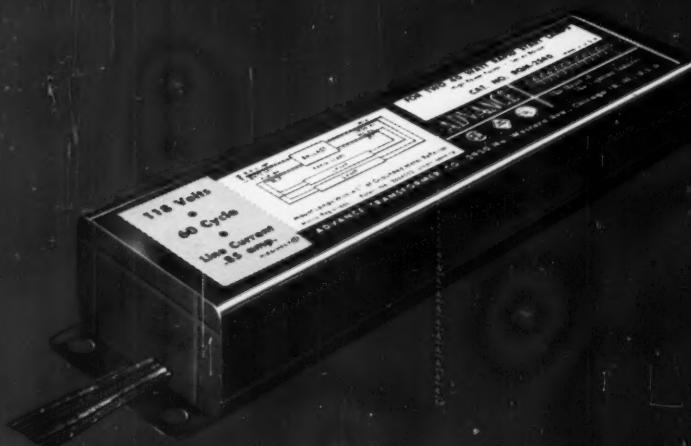
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ALCO steel mains with high-carrying coal-tar-enameled inside surfaces help New York City distribute over a billion gallons of water per day.

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One hundred years is a long time. Yet that is the estimated minimum life of ALCO electric-welded steel pipe in water-supply installations. Because of the strength of steel and the protection of coal-tar enamel, steel pipe lasts longer and maintains its high carrying capacity.

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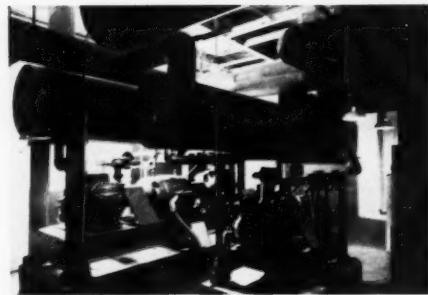
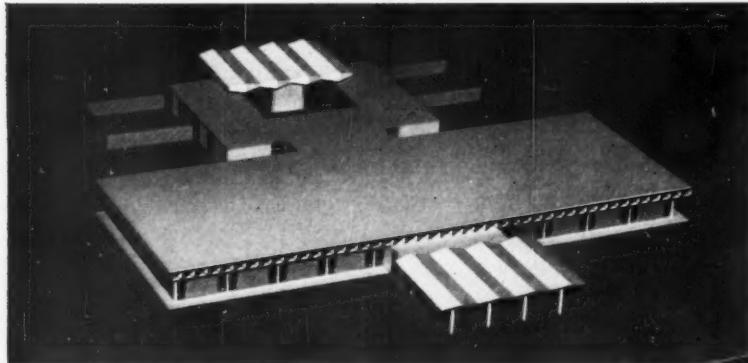
Architecturally, a "gem" . . . throughout, a model of modern office efficiency, beauty and comfort. That's the word on the new Atlantic City Electric Co. Accounting and Data Processing Center, Pleasantville, N. J. On the air conditioning system, the word is Acme, and according to H. C. Moore, Jr., of John H. Moore & Son, Mechanical Contractors, it's a very good word indeed. "The owners wanted a system, at a budget price, that would function quietly, efficiently, dependably . . . one that would be easy and economical to operate and maintain. Acme was selected and . . . thanks to the high quality and unsurpassed performance of Acme equipment . . . results have been excellent, the owners are completely satisfied."

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The d-c breaker you can buy today that won't be obsolete tomorrow

Actually this new-design model FB circuit breaker from I-T-E is somewhat of a phenomenon in its field. Of all breakers available for direct current, this is the only one that really makes use of today's modern materials and up-to-date knowledge of circuit breaker design. You might say it's the only modern d-c circuit breaker on the market today.

HIGH SPEED

In today's high-capacity d-c circuits, you *need* a high-speed breaker. Otherwise you risk thermal or mechanical damage to equipment—such troubles as commutator flashover in rotating equipment or arc-back damage to your rectifiers. Many circuits today still have semi-high-speed breakers that don't give adequate protection. At the time they were installed they may have been the best available. Or else high-speed breakers were too expensive. That isn't true with the FB. Without paying a premium price, you get high-speed operation. Current limiting action occurs *within 6 milliseconds*. And the breaker may be safely applied to 1000 volt d-c circuits having a rate of rise of 15 million amperes per second. So the FB breaker can be used with confidence in practically all d-c circuits.

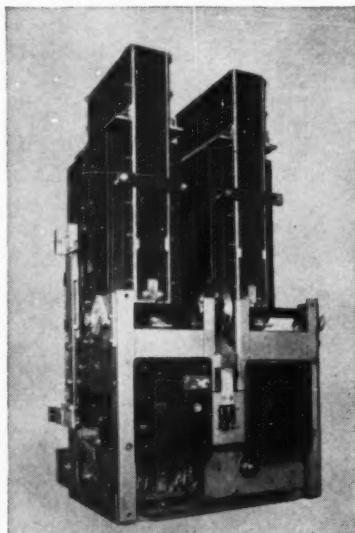
COMPACT SIZE AND LIGHT WEIGHT

Probably the most obvious difference between the new FB breaker and some of the old-design models still being sold is the greater compactness. This is one of the direct results of modern materials and technology. I-T-E engineers have given you actually superior circuit protection in less space. And the use of modern materials has shaved off many pounds of weight. Because of this they are now available in general-purpose enclosures. In addition, such new-design

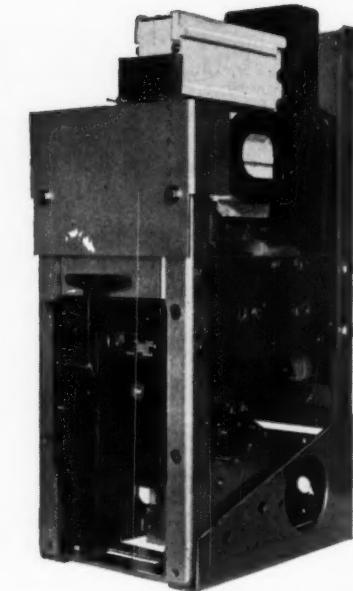
details as tilting arc chutes, elimination of flexible connectors, and exclusive drawout construction make this the easiest-to-maintain d-c circuit breaker you ever saw.

AVAILABLE IN 1 OR 2 POLES

If you are operating a single-wire grounded system, a single-pole circuit breaker arrangement will suffice. But suppose you are operating a 2-wire, ungrounded system. Then a 2-pole circuit breaker is desirable. And only the I-T-E model FB offers it. This is real 2-pole construction, with both poles fully integrated mechanically and electrically for simultaneous opening and closing under all conditions.



Stationary type single-pole FB breaker in 1200 amp rating with manual stored energy closing.



Drawout type 2-pole breaker in 6000 amp rating, electrically operated.

REALLY FUNCTIONAL MECHANICAL ADVANCES

Who but I-T-E would be first to give you an advance such as manual stored energy closing in a d-c circuit breaker? No slow burning of contacts with the FB. It closes in roughly 1/12 to 1/6 second for greater safety and longer contact life. You have your choice of either manual or electrical closing. The motor-operated closing mechanism draws only 5 amperes—a great advantage over the usual 50 amperes required by solenoids. Precision construction typical of I-T-E equipment, coupled with drawout design, permits complete interchangeability of breakers and parts in breakers of equal rating.

REPLACE NOW

There's questionable economy in trying to stretch out the life of old equipment that can mean costly downtime and inadequate protection. The wiser move is to replace now with new-design model FB breakers that are far ahead of the field. Models in capacities from 1200 through 12,000 amperes continuous and 1000 volts d-c. Write for the new detailed and illustrated Bulletin 4601-1A. I-T-E Circuit Breaker Company, Dept. SW, 1900 Hamilton St., Philadelphia 30, Pa.



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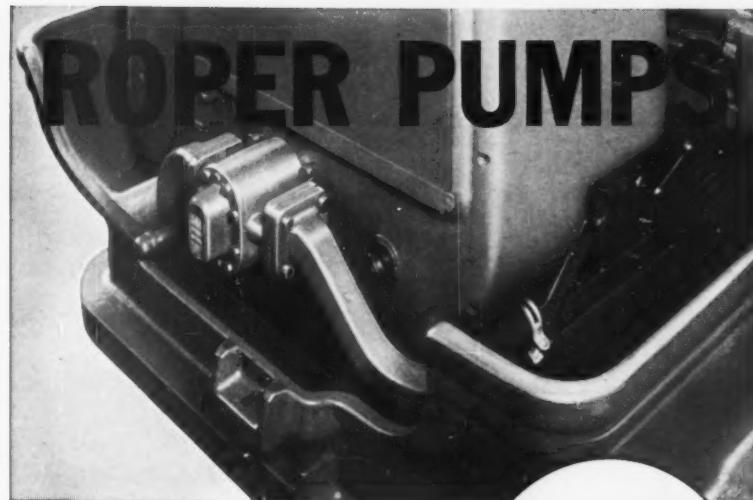
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Typical of the great adaptability of the compact Roper Series K rotary pump is its service as a coolant pump in supplying soluble and cutting oils to this automatic screw machine. The requirement for instant priming in this machine requires a positive displacement pump. The rugged Series K meets the specifications of many original equipment manufacturers who require dependable, quiet, efficient transfer of clean liquids in hydraulic service, fuel supply duty for large oil burners, or diesel fuel oil transfer. Special fittings for transfer of corrosive liquids and special mountings to meet installation requirements can be supplied. Series K models can be direct connected, chain-, belt-, or gear-driven. Precision construction and thorough individual pre-testing insure its durability of performance. Specify Roper for rugged dependability.

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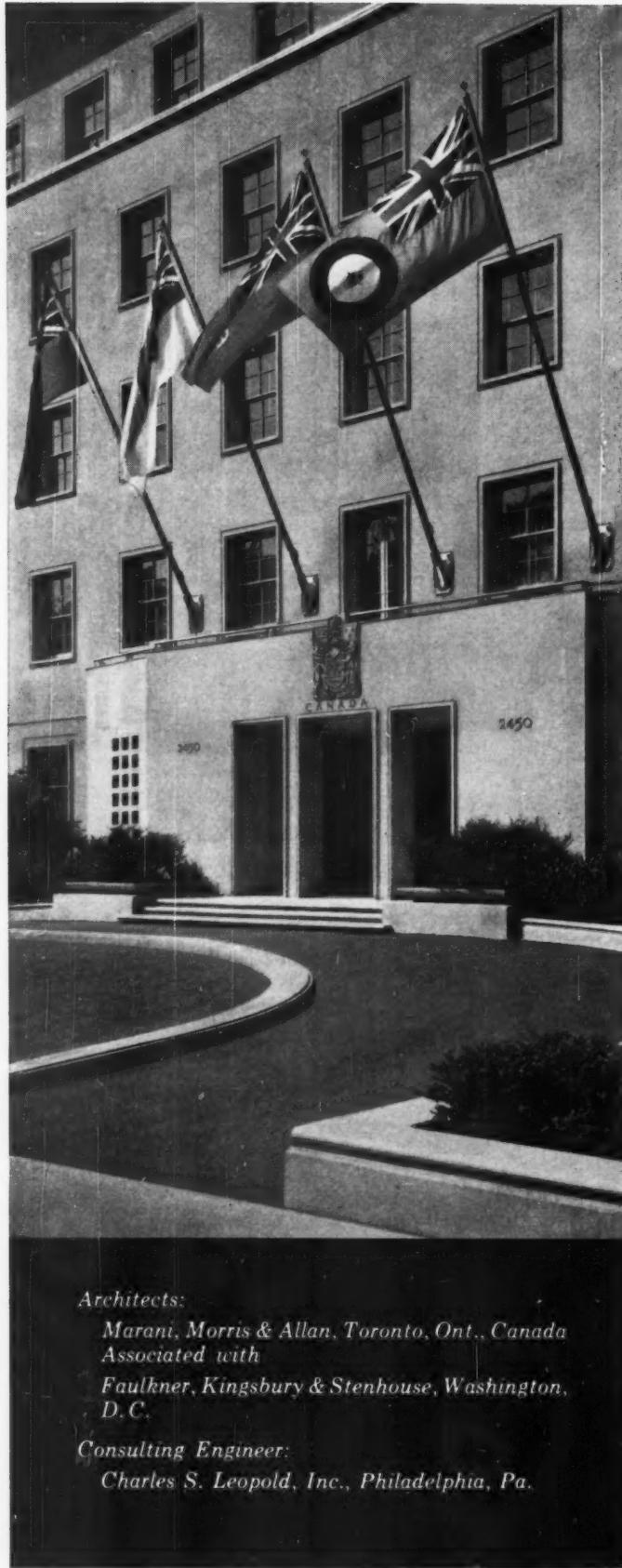
- Simplified design . . . only two moving parts
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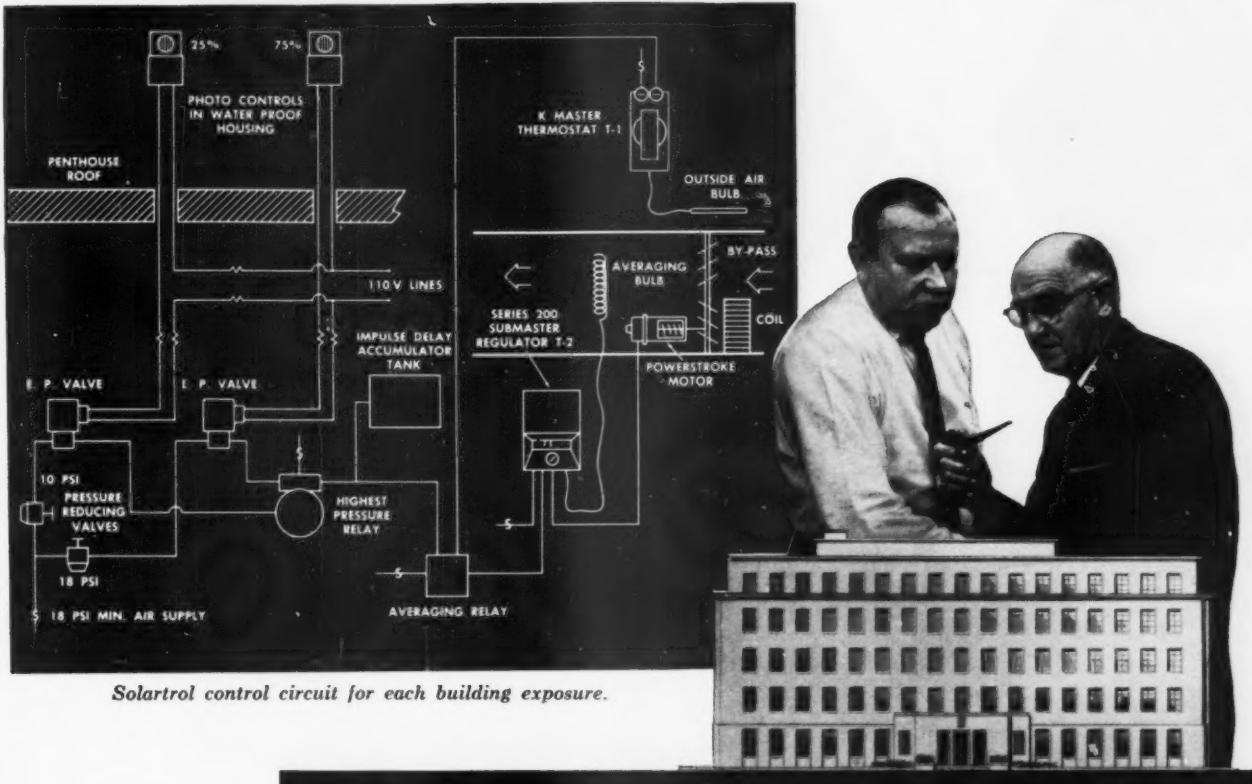
Consulting Engineer:

Charles S. Leopold, Inc., Philadelphia, Pa.

HOW TO SAVE COOLING DOLLARS WITH SUNPOWER

Consulting Engineer, Charles S. Leopold, confirmed his reputation for imaginative engineering when he put the sun to work in the air conditioning system of the Canadian Joint Staff Building, Washington, D. C. As a result, the occupants enjoy year-round comfort.

The Powers SOLARTOL, an electronic-pneumatic system designed to measure solar intensity and regulate air conditioning systems accordingly, is used to accomplish this.



Solartrol control circuit for each building exposure.

G. Titus Fenn, chief designer, and Charles S. Leopold.

HOW IT WORKS—Four pairs of photo-electric cells are mounted on the roof, each pair measuring the solar radiation falling on one side of the building which is oriented 45° from the true north-south. They are connected to submaster thermostats that control conditioned air temperature for each exterior zone in the building. One cell of each pair is set to operate at 25% Solar Gain and the other at 75%.

With no sunlight, an outdoor-air master-thermostat regulates the conditioned air temperature. As outside temperature rises from 78° to 95°, the zone air supply controls reset through a range of 68° to 63°.

With 50% Solar Intensity, the thermostat controls for that particular building zone are ad-

justed to operate at a 5° lower temperature range — 63° to 58° — to compensate for the additional heat of the sun.

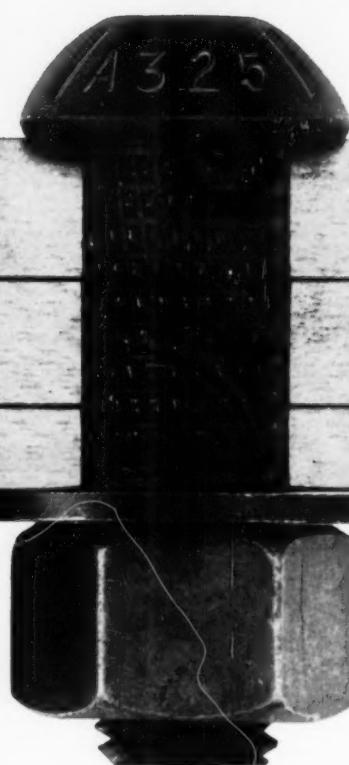
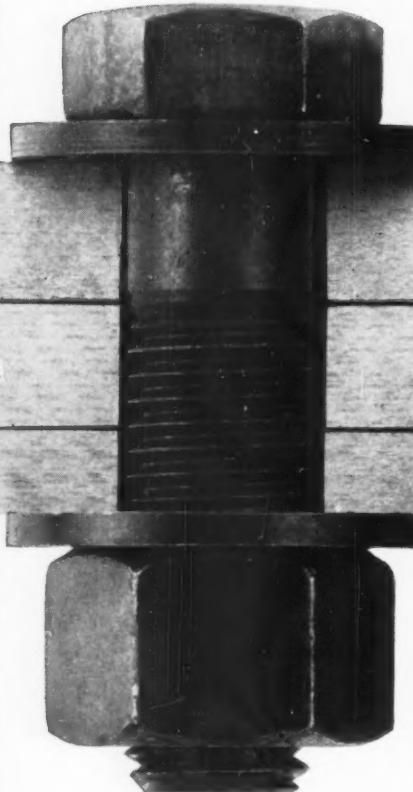
With 100% Solar Intensity, the zone air supply controls are adjusted to operate at a still lower temperature range — 59° to 54°.

By varying the temperature of the air in the zone duct according to solar intensity as well as outdoor temperature, the final room controls operate more accurately. Equally important is a definite economy of refrigeration.

Powers controls systems and "Imaginative Engineering" — are establishing new highs in comfort conditioning. Case histories are available — ask for them.



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ORIGINAL HIGH STRENGTH BOLT (a four-piece assembly)

Requires two washers, two wrenches or impactor sockets of different size. Offers fewest opportunities for "two-for-three" substitution in "bearing-type" connections, due to long length of thread.

Regular semi-finished head requires a washer to provide adequate head bearing area. No bolt length code number on head. Two-man bolt-up crew required.

NEW "STRUCTURAL" BOLT (a three-piece assembly)

Single washer under head or under nut—whichever is to be torqued. Short thread is excluded from shear plane of members for "bearing-type" connections, except where thin outside parts are adjacent to nut.

Head clearance, stick-through, and minimum thickness of outside members vary depending on location of washer.

Larger heavy hex head does not require washer, unless head is to be torqued. Same wrench used for head and nut. Lamson "Structural" Bolts carry bolt length code number on head. Two-man crew required.

HIGH STRENGTH BEARING BOLT (a three-piece assembly)

Only one washer required. Bolt drives easily, since knurls are ball-shaped, set in spiral pattern. In most grips, bolt can be "pulled" into place by impacting nut. Tolerates as much misalignment as smooth-shank, loose-fit types of bolts.

Closely controlled unthreaded body length reduces to a minimum the possibility of thread being in shear plane of connection. Greatest opportunity for "two-for-three" substitution.

Rivet-type head has about 35% more bearing area than new "structural" bolt head. Head clearance is constant, and overall bolt length is always $\frac{1}{8}$ " shorter than "structural" bolt length. Lamson High Strength Bearing Bolts carry bolt length code number on head. Can be assembled by one man.

New structural bolting specs approve increased allowables, recognize three types of structural bolts

New specifications by the Research Council on Riveted and Bolted Structural Joints, and endorsed by the AISC, now approve:

A. Three types of structural (ASTM A325) bolts.

1. Regular semi-finished hex head bolt (original high strength bolt).
2. Heavy semi-finished hex head "structural" bolt (new structural bolt with modified heavy hex head and short thread).
3. Interference body bolt (Lamson High Strength Bearing Bolt).

B. Two types of nuts.

1. Present heavy semi-finished hex nut.
2. Finished hex nut (Grade 2H-ASTM A194 finished nut).

C. Round hardened washers.

1. Round hardened washers are now $\frac{1}{4}$ " smaller O.D.

D. Two tensile/shear allowables.

1. A new tensile/shear ratio of 1.0:1.1 for Bearing-Type connections.
2. The present river allowable of 1.0:0.75 applies to Friction-Type connections, and to Bearing-Type connections where bolt threads are in the shear plane of the connected members.

NEW TENSILE/SHEAR RATIO MEANS MAJOR COST REDUCTION

The new 1.0:1.1 ratio permits use of fewer bolts in bearing-type connections. As a rough example, two ASTM A325 structural bolts can now be used instead of three rivets, provided threads are excluded from shear planes. Major cost reductions are possible as a result of fewer holes, bolts, nuts, and washers—reduced layout and bolt-up time. Rivet allowables still hold for friction-type connections.

WHICH BOLT IS BEST?

Right now you have a choice of three types of bolts. (All are made by Lamson). The original high strength bolt may be "phased out" in the future—so your choice is really between the new "structural" bolt and "interference-body" bolts, such as the Lamson High Strength Bearing Bolt.

Certainly the new "structural" bolt improves upon the original high strength bolt. But the High Strength Bearing Bolt is an engineering breakthrough—not just a refinement—and as such, provides major advantages over other types of bolts.

Use of the Lamson High Strength Bearing Bolt results in stronger structures at no increase in cost.

BEARING BOLTS LET YOU TAKE FULL ADVANTAGE OF THE "TWO-FOR-THREE" SUBSTITUTION

The revised specification requires shear connections to be friction-type when:

1. Subjected to stress reversal, severe stress fluctuation, impact or vibration.
2. Slippage would be undesirable.

The High Strength Bearing Bolt fills the hole in initial bearing for maximum resistance to slip. Thus, connections that would be "friction-type" under No. 2 above, for smooth-shank bolts in loose-fit holes, are "bearing-type" when Bearing Bolts are used.

Therefore, using Bearing Bolts, the "two-bolt-for-three-rivet" substitution can be made in many more connections than with other types of bolts.

BEARING BOLTS EXCEL IN FRICTION-TYPE CONNECTIONS

More than anything else, the specially designed knurled body is responsible for the Bearing Bolt's outstanding performance in friction-type connections in critical structures—including railroad bridges, mill buildings, ore buckets, process machinery, cranes, towers and radar antennas.

The Bearing Bolt's combination of body-bound fit and high clamping strength reduce to a minimum any possibility of movement between the connected members.

BEARING BOLTS EXCEL IN BEARING-TYPE CONNECTIONS

Why use High Strength Bearing Bolts in a "pure" bearing-type connection—where loads are static and not subject to stress reversal, impact or vibration? Even though the big advantage of the body-bound fit may not come into play, many engineers have said in so many words that *Bearing Bolts give them extra peace of mind*. Facts behind their thinking:

COMPARISON TABLE			
	1952 High Strength Bolt	1960 Heavy Semi-Finished "Structural" Bolt	1958 High Strength Bearing Bolt
ASTM designation	A325	A325	A325
Comparative shear strength (% of dia. bolt)	100%	100%	113%
Min. tensile strength requirements	90,000 to 120,000 psi	90,000 to 120,000 psi	90,000 to 120,000 psi
Source of strength	friction based on high clamping force	friction based on high clamping force	shear and bearing, plus friction clamping
Fatigue:			
Static	good	good	good
Dynamic	good	good	good
Resistance to slippage	good	good	excellent
Resistance to vibration	good	good	excellent
Best application	field connections	field connections	shop and field connections
Type of connections	all	all	all
Specific uses	buildings, bridges, towers	buildings, bridges, towers	buildings, bridges, towers, machinery, materials handling equipment
Men required to install (minimum)	two	two	one
Manpower	readily available	readily available	readily available
Time required to train men	one-half day	one-half day	one-half day
Method of installation	insert, hold head, apply measured torque	insert, hold head or nut, apply measured torque	insert, drive or pull, apply measured torque
Equipment required	hand wrench, impactor	hand wrench, impactor	impact wrench, maul
Washers required	two-heat treated	one-heat treated	one-heat treated
Installation cost	less than rivets	less than rivets	less than rivets
Shop painting permissible	yes, for static direct loads only	yes, for static direct loads only	yes
Maintenance	easily removed & reused	easily removed & reused	easily removed & reused

*Actual test results available on request.

Bearing Bolts have 10%–15% greater shear values, approximately 10% larger body bearing area. Close control of grip length on the unthreaded portion of the body assures excluding the thread from all shear planes in the connection, except for extremely thin outside parts adjacent to the nut.

While this advantage also holds true for the new "structural" bolt, the use of Bearing Bolts permits assembly of substantially thinner members free from this limitation.

For stronger structures—and extra peace of mind—specify High Strength Bearing Bolts.

PRICE AND DELIVERY INFORMATION ON ALL THREE TYPES OF STRUCTURAL BOLTS

U.S.S. Supply Division of United States Steel Corporation, exclusive stocking distributors of Lamson Structural Bolts, maintains 19 strategically located Service Centers throughout the country. Call the one nearest you for price and delivery information.

SAMPLE BOLTS, ENGINEERING DATA

Write Lamson & Sessions for (1) sample structural bolts; (2) up-to-date grip vs. bolt length chart; (3) a copy of the revised specifications for structural joints using ASTM A325 bolts; (4) any other application information required.



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Craig P. Hazelet

— Starts on front cover

"Most civil engineers, and I am sure this holds true for engineers in all branches of the profession, sincerely want to conform to the Code of Ethics. When they do not conform, it frequently is due to the fact that in certain areas the intent of the Code has not been clearly spelled out. With respect to enforcement of the Code, I certainly do not favor a soft policy toward clear-cut violations. I do, however, favor dealing with professional people in a professional manner."

Hazelet agrees that the most frequent violations reported in the past were those concerned with outright competitive bidding. However, it appears that violations of this character are gradually disappearing. "I prefer to think that, instead of indicating a temporary lull, this is due to the very effective educational campaign ASCE has carried on with federal, state, and municipal agencies as well as within its own membership. Engineers are gradually becoming more conscious of what is expected of them and I might add that word has gotten around that ASCE makes every effort to act promptly on competitive bidding complaints. We are, however, still concerned with those cases which are not outright violations but lie within a difficult to define gray area. It is hoped that the new Rules of Practice will clear up any ambiguities, and that, these marginal cases will gradually disappear. In sum, vigorous and prompt action, coupled with a continuing educational campaign, is indicated."

Advertising

Recently ASCE, through its Committee on Professional Conduct, has taken a renewed interest in the question of the ethics of advertising. It has been proposed that the rules in regard to consulting engineers be clarified. Hazelet thinks this definitely should be done.

"The question of whether or not consulting engineers should be permitted to advertise may be difficult to resolve. The present code of ethics definitely prohibits statements of self-laudatory character. It also precludes advertising in any other manner derogatory to the dignity of the profession. Opinions within the membership vary from those who would bar any type of advertising, including professional cards in engineering magazines and technical periodicals, to those who would let down the bars completely. I am unable to accept either of these extreme views. It seems to me we should be able to adopt some standards which would clearly indicate what is within the limits of good taste and in conformity with the Code, as contrasted to the crass commercial type of ad."

It is quite universally conceded that the engineering profession has never been accorded the same respect or recognition by the public generally as have the professions of medicine and law. This in some measure may be due to the fact that in the practice of medicine and law the contact is of a more intimate and personal nature. In the engineering profession, our client is the impersonal public. The public has a great stake in all major engineering undertakings and has a right to be fully informed with respect to those who are directing the work on its behalf. The engineering profession on the other hand deserves greater recognition than it has had in the past. Therefore, it does not seem unreasonable or unprofessional to explore the possibility of achieving better understanding through public relations. The approach might include the advertising media — tailored, of course, to the special requirements and ideals of the engineering profession.

"Any action looking toward a re-examination or liberalizing of the restriction on advertising should, if possible, carry with it the full cooperation of all professional groups. This would be one more step toward unity."

The Lure of Alaska

Born in Nebraska, the son of a teacher, Hazelet grew up on the frontiers of Alaska. His father went to Alaska during the Gold Rush of 1898, having obtained financial backing to develop placer mining in the interior. The family moved to Valdez in 1903. At this time, the senior Hazelet also was busy starting the first standard gauge railroad in Alaska territory.

Hazelet's first job, at the age of 10, was selling newspapers. It was much more glamorous in Alaska than in the States, for in those days boats brought papers from the outside only every two or three weeks and the Alaskans were eager for news. Soon Hazelet graduated from news peddling to driving a horse-drawn wagon for a grocery store.

Although the Hazelet family spent enough winters in Alaska to earn the title of sourdough, many winters were spent in Seattle and San Francisco. But growing up on the frontier is considered an advantage by Hazelet. "I was doubly fortunate in having Charles Bunnell, later the first president of the University of Alaska, as the teacher in our small school district." Later, Hazelet chose the University of Washington for civil engineering.

While he was in college, Hazelet worked summers as location surveyor for the Copper River & Northwestern Railway in Alaska. "We lived on a railroad siding in box cars and tents. I can remember hitting the canoes at 7 a.m., paddling 10 miles upstream and then, after a rugged day, racing

ACTUAL TESTS* PROVE

Allen-Bradley Standard Duty Push Buttons can be installed *in about half the time!*



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How come only famous A-B standard duty push buttons possess this time and moneysaving advantage?

The answer lies in the molded, wrap-around cover—which also contains the contacts. When the cover is removed, the wiring terminals are *out in the open*—ready for wiring—and you have plenty of working space. The two cover screws are captive—they cannot fall out and get lost. And with the contacts in the cover, they are protected against accidental damage and careless wiring. Naturally, these push buttons have double break, silver contacts that never need service attention. There are two concentric knockouts on each end of the base, which are removed from the outside—the heavy, pressed steel base will not bend out of shape.

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*Using recognized standard duty push buttons, installations were made by an experienced electrician under identical conditions. He was not connected with Allen-Bradley Company in any manner.



A-B STANDARD DUTY PUSH BUTTONS
Made as a one-, two-, or three-unit station—with pilot light available. Readily changed for horizontal or vertical mounting. Convertible two- or three-way selector switch supplied with or without pilot light.

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*Gary Galok**

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Lighter Weight! High strength to weight ratio. Minimum deflection . . . easier to install.

Better Looking! Can be used for decorative purposes, sun shades, grilles, etc. Can be anodized in sunfast colors to blend with surroundings.

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Write for Bulletin C14R

Dept. L-7, E. Seventh Ave., Gary, Indiana
*Patent Pending

ROCKWELL-STANDARD
CORPORATION



Grating Division, Gary, Indiana

back to camp at 5 p.m. My brother, who was studying mining engineering, worked summers in the interior at a placer mine."

After receiving his bachelor of science degree in civil engineering, Hazelet went to work for the Kennecott Copper Corporation's Bonanza mine (the richest copper vein in the world) in the Alaskan interior. Although the temperature got as low as 69 degrees below zero, the job had advantages. Hazelet recalls that he was paid \$125 a month with room and board. At that time, beginners in civil engineering were getting between \$60 and \$90 a month in the States.

"I did a little of everything — setting lines and grades for foundations in the field and drafting in the office." After two years on this project, young Hazelet transferred to LaTouche Island on another Kennecott project. "My primary impression of this spot was that it rained constantly. We lived in slickers."

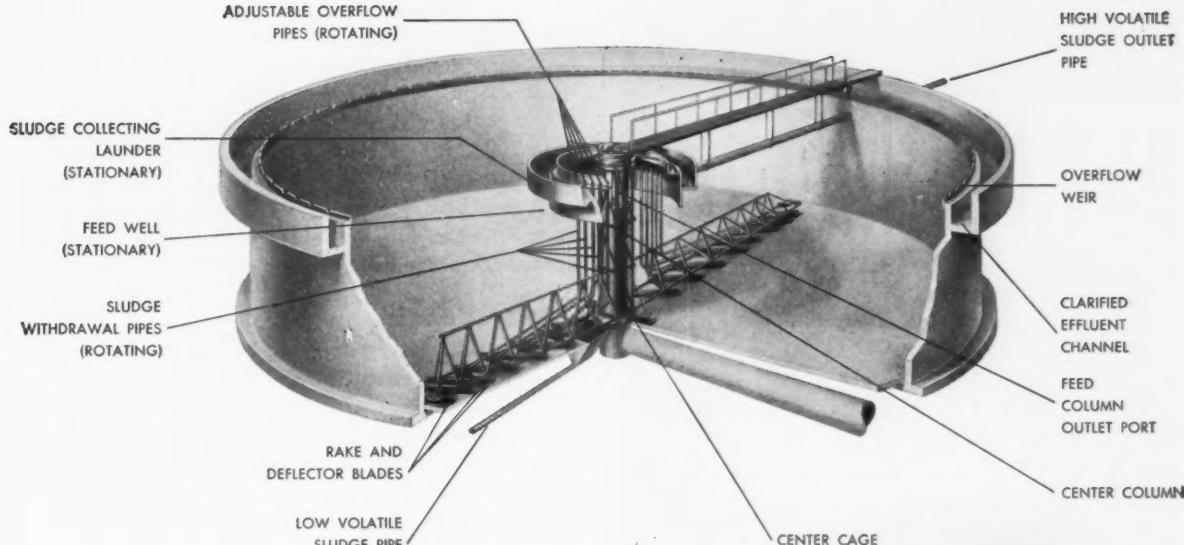
Advanced Training

Even in those days, Hazelet did not consider four years' study sufficiently magical to turn a man into a civil engineer. At LaTouche Island he worked with graduates of Yale, MIT, the University of Colorado, Houghton School of Mines, and other top engineering schools. They convinced him that, since his degree was from a western school, he should do graduate work in the East. So he enrolled in hydraulics and structural courses at MIT. About one year later, World War I started, and despite poor sight in one eye ("I was born wearing glasses") he finally was able to enlist in the Corps of Engineers. Just as the division was mobilized to leave for Russia, the war ended.

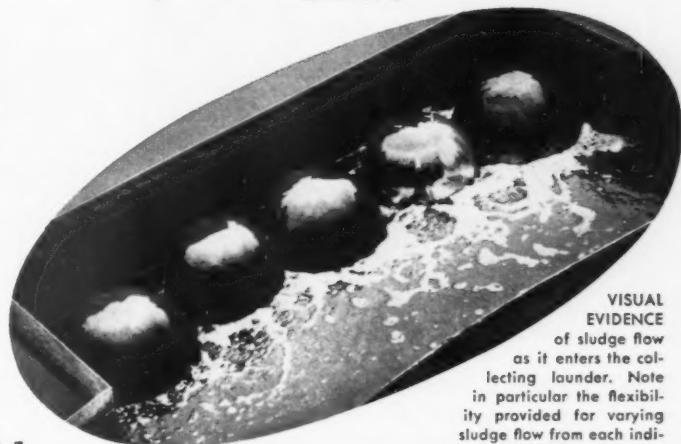
Instead of continuing his studies, he returned to Boston and got a job at Fay, Spofford & Thordike as a structural designer. After he had been there for several months, the young engineer had an opportunity to go North again — at the irresistible salary of \$300 a month as a designer and field engineer on mill construction for a Canadian mining company near Sudbury, Ontario.

When this job was completed, Hazelet went to Detroit where he worked briefly for Ford Motor Company on the design of a power station for their River Rouge plant. "Life was too regimented, so I resigned and went to work for Smith, Hinchman & Grylls, architect-engineers, as a designer of industrial and office buildings." Soon work slowed down and many of the younger employees had to look elsewhere for work. Three weeks after losing his job, Hazelet married. This gave him added incentive to find a good job quickly.

An offer came along that surprised him — he was asked to teach civil engineering at the University



3-WAY CAPABILITY of the RSR Clarifier to make high-volatile sludge, low-volatile sludge and clarified effluent separation is illustrated in the cutaway drawing.



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of sludge flow
as it enters the collecting launder. Note
in particular the flexibility provided for varying
sludge flow from each individual uptake pipe.

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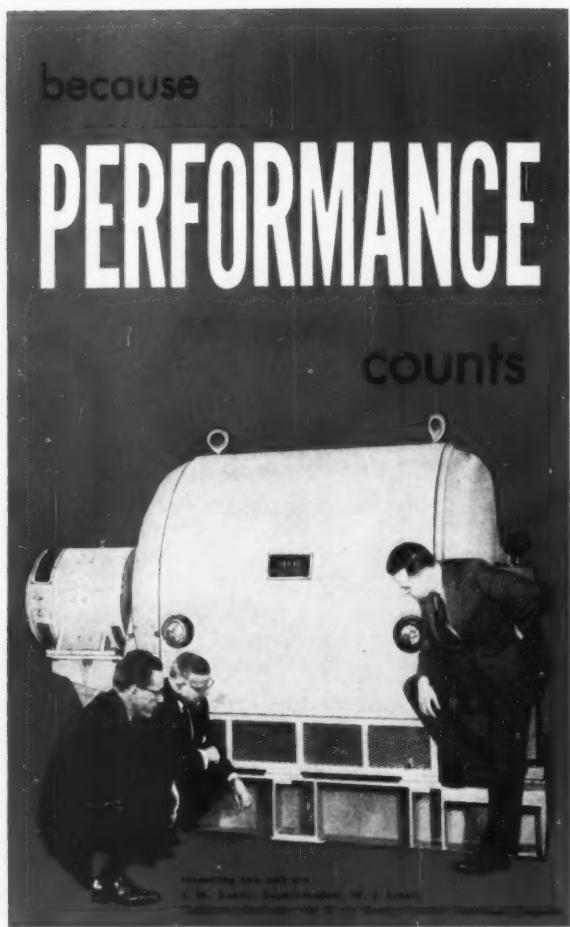
For rapid removal of fresh sludge on a continuous basis, the Dorr® RSR Clarifier affords visual evidence of quality and quantity of sludge removed from secondary clarifiers. This is accomplished by removal of sludge from the entire floor area by rotating uptake pipes. Simple adjustment provides for controlled rate of sludge removal from each individual pipe.

In operation, a combination of rake and deflector blades channel the fresh sludge to an area under the

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of Illinois. Since this presented an opportunity for further graduate study, he happily accepted the job. While teaching, he worked summers as a draftsman for Holobird & Root, Chicago architects. At the next drafting table sat a Norwegian engineer, Ingolf Erdal.

In 1922 Hazelet left the University to accept a position with the Scherzer Rolling Lift Bridge Company, of which he later became president and chief engineer. The firm had been formed in 1897 to specialize in fixed and movable bridges.

Into Private Practice

After going with the bridge company, his first task was to reorganize the engineering department. He remembered Erdal and traced him to the Chicago, Burlington & Quincy Railroad where he was checking shop drawings. The two began an association which lasted until 1950, when Erdal retired and was succeeded by A. L. R. Sanders, an associate of the firm for many years.

"We barely coasted through the depression. I was never happy working under a corporate set-up so after operating for 14 years as the Scherzer Rolling Lift Bridge Company, we liquidated the company and formed a partnership in 1936."

Because of the "Lift Bridge" in the former name of their firm, the partnership had rough going at first. "Somehow, people never thought of us in terms of anything but lift bridges. We had to take any small jobs that came along outside our supposed specialty to get away from the stigma of knowing nothing but the design of lift bridges. I can remember one project we handled—a 20-ft clear span bridge at Coffee Pot Bayou, Florida. The job was so small our profits barely covered the expenses of the inspection trip. But we had to start somewhere."

The young firm gained attention—and a very welcome \$5,000—in an unexpected manner. In 1938, when elevated highways were still an oddity, Hazelet & Erdal entered an international design contest sponsored by the American Institute of Steel Construction. They won first prize for their four-lane roadway supported on cantilevered floor beams atop a central bent. "We called our entry the wine glass design," Hazelet commented.

Last year Hazelet served on the Jury of Award for the Steel Highway Bridge Design Competition sponsored by the American Bridge Division—U. S. Steel Corporation in cooperation with the American Institute of Steel Construction.

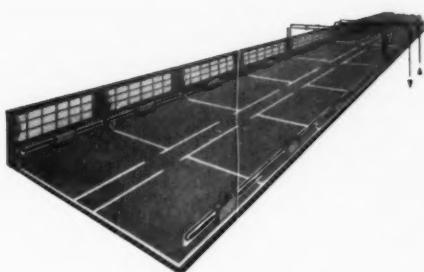
Another War

With the coming of World War II, it looked as if the partnership would go out of business. Bridge priorities were frozen and Hazelet haunted the



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various construction bureaus in Washington attempting to get clearance on defense projects. Since theirs was a small firm, and war contracts were going to larger organizations, Hazelet & Erdal joined three other small consultants in a joint venture.

After successfully completing the \$18 million Green River Ordnance plant, at Dixon, Illinois, they got another government project. But it was not what any of the firms in the joint venture had expected. They were asked to set up an office in Cincinnati to handle the over-all direction of an Army Transportation Corps program for the design and construction of ships and harbor craft involving construction costs of \$1 billion. "That billion dollars had no relation whatsoever to the fee, but then I do not believe in making excessive profits on war contracts," Hazelet said. "On this project, we walked into an unbelievable situation. Ships were being built by about 100 small shipyards, each tailoring their designs to their sources of material — all different." The head of the naval architecture department at the University of Michigan was called in, all the engineers were given cram courses in naval architecture, and the project was completed after 18 months of intensive work.

In early 1945, a shortage of ammunition was developing. Hazelet & Erdal was asked to set up an office in Louisville, Kentucky to undertake the design and supervision of construction for a \$6 million expansion of the Hoosier Ordnance Plant at Charlestown, Indiana.

By the time the war ended, the Louisville office had begun to develop peacetime possibilities. As a result, the partners decided to continue the office on a permanent basis. "Mrs. Hazelet and I found Louisville a delightful place to live and we decided to make it our permanent residence." The Hazelets live in an old stone house which was built in 1790 and is one of the oldest in the Louisville area. It was constructed while Kentucky was still a part of Virginia and has been owned by only three families.

Today, Hazelet's firm has a total of approximately 140 men in its four offices. In addition to many major projects in this country, the firm has handled the design of 18 structures in foreign countries, including France, England, Spain, and China. The principal bridges in this country designed or currently under way include cantilever spans over the Mississippi River at East St. Louis (with a 964-ft main span), over the Ohio River at Parkersburg (double deck twin tied arch of 800-ft span), over the Ohio River between Louisville, and New Albany, Indiana (multiple cantilever of 800-ft spans), over the Ohio River between Louisville and Jeffersonville, Indiana (multiple cantilever with 800-ft

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DECEMBER 1960

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main span), and over the Ohio River at Evansville, Indiana. A combined railway and highway lift span over Portage Canal at Houghton and Hancock is another recent project.

The firm also has handled the reconstruction of quite a few large bridges. "Perhaps one of my favorite projects was the reconstruction of the Covington-Cincinnati Suspension Bridge over the Ohio River. This bridge was started in 1857 by John Roebling and completed after the Civil War. It was the longest span in the world until the Brooklyn Bridge was completed in 1883. This is the second reconstruction of this bridge. In 1895 it had to be reconverted from its original design when the traffic changed from horse-drawn vehicles to electric railroad. The recent reconstruction (\$610,000) includes an open grid steel deck, repairs to the stiffening trusses, floor beam columns and struts, and repainting."

Professional Societies

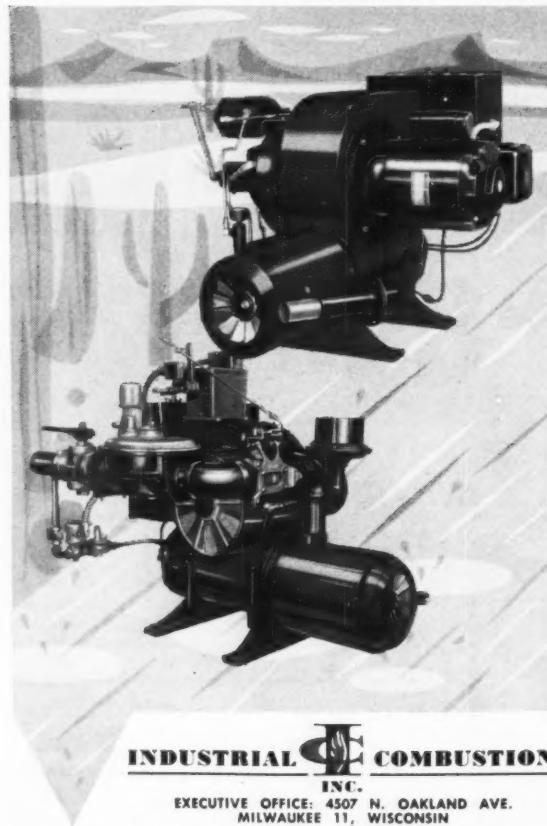
Although Hazelet has devoted most of his professional efforts to ASCE, he also is a member of the American Institute of Consulting Engineers, the Consulting Engineers Council, the National Society of Professional Engineers, and the U. S. Council of the International Association of Bridge and Structural Engineering.

"I do not have the time to take an active role in CEC, but I encourage the other men in my firm to do so," he commented. "I think CEC has done an amazing job in a very short time, and I would like to see CEC cooperate in their Washington work with such organizations as the American Road Builders' Association Engineering Division in the future. I think Congress is more likely to listen to the combined voices of the two groups."

Hazelet still takes a very active interest in education, as evidenced by the fact that his firm sponsors two scholarships in civil engineering, one at the University of Kentucky and the other at the University of Louisville. These scholarships are available to upperclassmen and graduate students on the basis of need and merit.

He also has served on the MIT educational Council for the past six years. The function of this Council is to screen potential MIT students in his area. He is currently area chairman for the MIT Second Century Fund.

"I enjoy talking with young men and following their careers. There is nothing more important to our nation than strengthening our educational system, particularly in the fields of science and engineering. The conquest of space and all it entails opens up new opportunities for men in all branches of engineering." □



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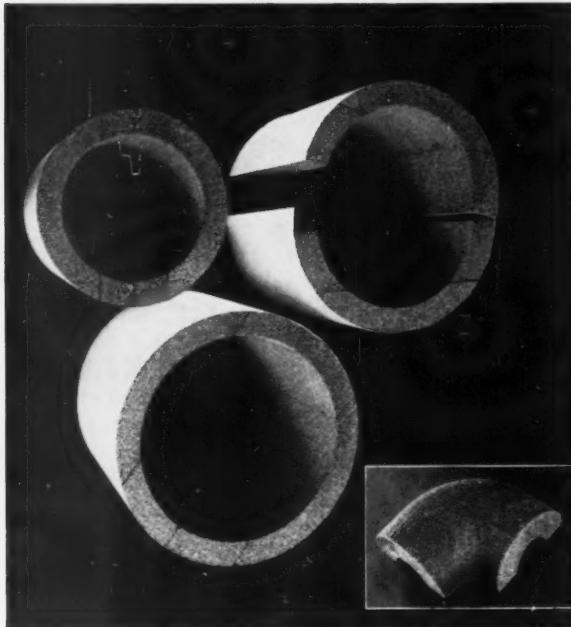
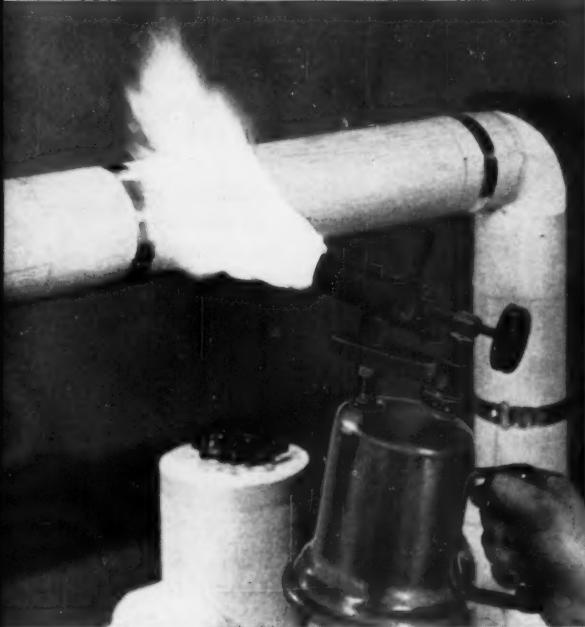
Next is the elimination of all weak spots in piping runs. The extraordinary compressive strength of FOAMGLAS prevents slump or sag on the highest vertical runs and saddle supports can never puncture the insulation. Fourth, the insulation is furnished with a factory applied Kraft-foil jacket. And fifth, all these benefits can be applied to total piping systems since FOAMGLAS Stay-Dry Pipe Insulation is available in sizes from $\frac{1}{2}$ " copper tubing to 12" IPS with fitting covers and elbows to match.

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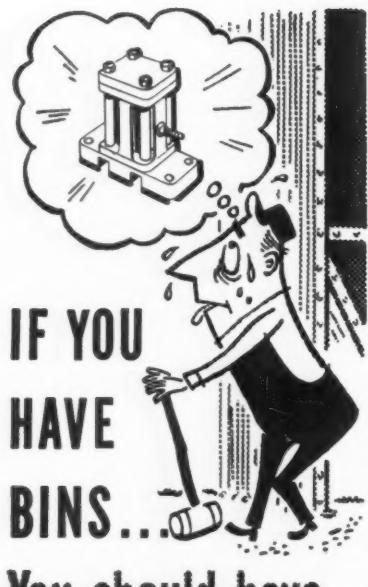
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Readers' Comment



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12N-2829 Clinton Ave., Cleveland 13, Ohio



Sewage Treatment

I would like to compliment those on your staff who worked on the article on Sewage Treatment in the September 1960 issue of CONSULTING ENGINEER.

The theory of sewage treatment has not changed much in the last 25 years. It is true that sanitary engineering is a new field. It also is a very complex field that involves the knowledge of chemistry, bacteriology, and so-called sanitary engineering. For the practicing consultant it also involves structures, hydraulics, and the practical knowledge of what materials to use and what equipment to specify.

The article did not present anything new, but surveyed the entire field in a very interesting manner.

I am confident that the field will accelerate at a faster pace in the future. Your article is a definite contribution.

Dan D'Addona
McNamee-Porter-Seeley
Ann Arbor, Michigan

Fan Mail

. . . a note telling you how interesting and important your magazine is. In particular, I'm thinking of your comprehensive coverage of sewage disposal in the September issue. The historical articles by James Kip Finch, also, have had

my interested attention. Then there are interesting and important details, such as "Sunshine and Shadow and Building Design." CONSULTING ENGINEER brings something new and refreshingly different every month, and I am always glad to receive it.

John Merrill Weed
Columbus, Ohio

Clarification

In reading the October issue of CONSULTING ENGINEER I came across a rather disturbing mention on page 212 under "Men in Engineering."

The notice seems to imply I no longer have a practice of structural engineering. I have had a practice at 1414 Fair Oaks, South Pasadena under the name of John Kariotis and Associates since the dissolution of my former partnership.

Would you please correct the impression as soon as possible.

John Kariotis
South Pasadena, California

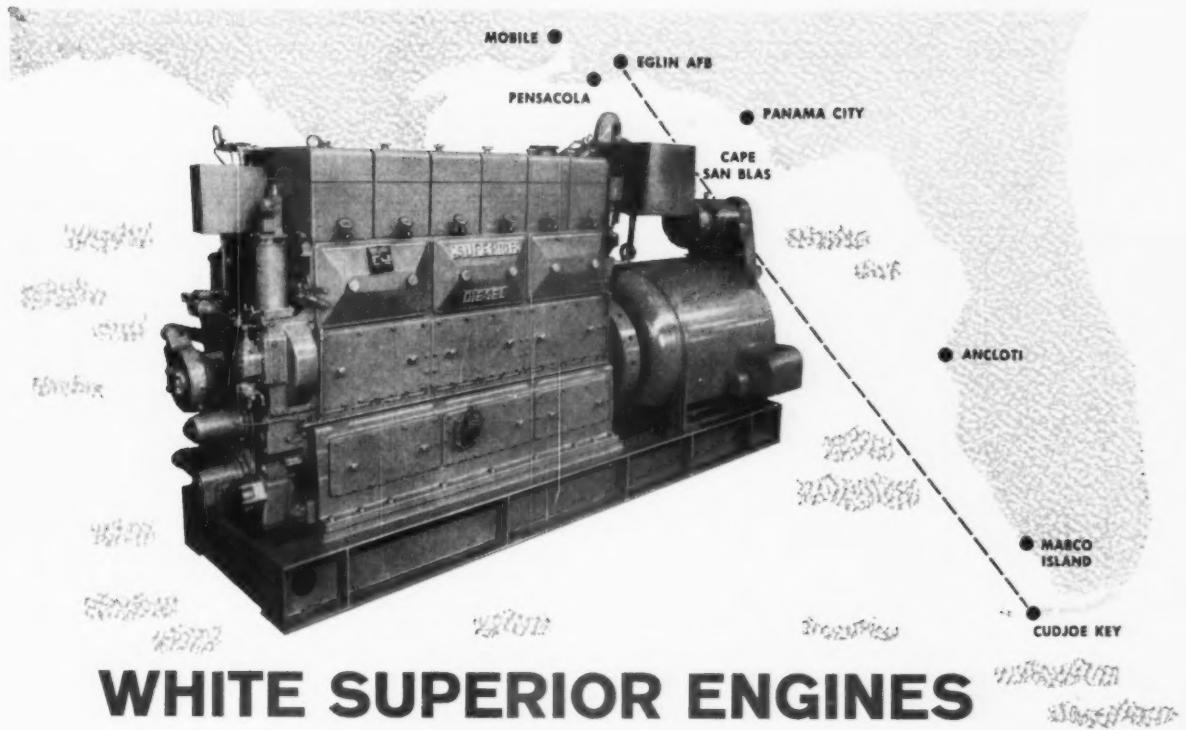
In More Hot Water

Re: "A Hot River Hassle," CE, October 1960. I get a nasty feeling when I read ". . . according to the U. S. Public Health Service."

A certain government owned manufacturing facility has been creating and maintaining an increased temperature for a long distance along the Columbia River. Strange to say, the U. S. Public Health Department has missed a bet by not clamping down on that heat. The waste heat could have heated many communities—or provided power.

Why not use the heat like the Servel Refrigerator process and cool the waste?

C. A. Hillegass
Los Angeles, California



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help "keep score" at one of
America's newest missile ranges

The Eglin Gulf Test Range (EGTR), consisting of five missile tracking stations, extends 450 miles from Eglin AFB, Florida down the west coast to Cudjoe Key, 23 miles east of Key West. At Eglin AFB and at three of the five tracking stations, power is supplied by White Superior Model 40-SX-6 engine-generator sets. Each of the five Superior engines on EGTR develops 361 BHP to produce 250 KW. At Cudjoe Key (shown below), two of the Superiors provide power for range safety equipment, trajectory measuring systems, drone control and telemetering devices, from which data is sent back to Eglin.

America's newest missile range joins an impressive list of Superior-powered U.S. defense installations, which include the "Texas Towers," portions of "DEW" line and the "SAGE" project, Atlas and other launching stations, and other missile tracking ranges. Government acceptance of White Superior engines for these installations is proof that Superior meets all requirements for rugged dependability, trouble-free maintenance and maximum fuel economy. Superior engines, from 215 to 2150 HP or 150 to 1500 KW, can likewise be custom-engineered to meet your exact requirements, including automatic, unattended or remote controlled operation. Write for complete information today!



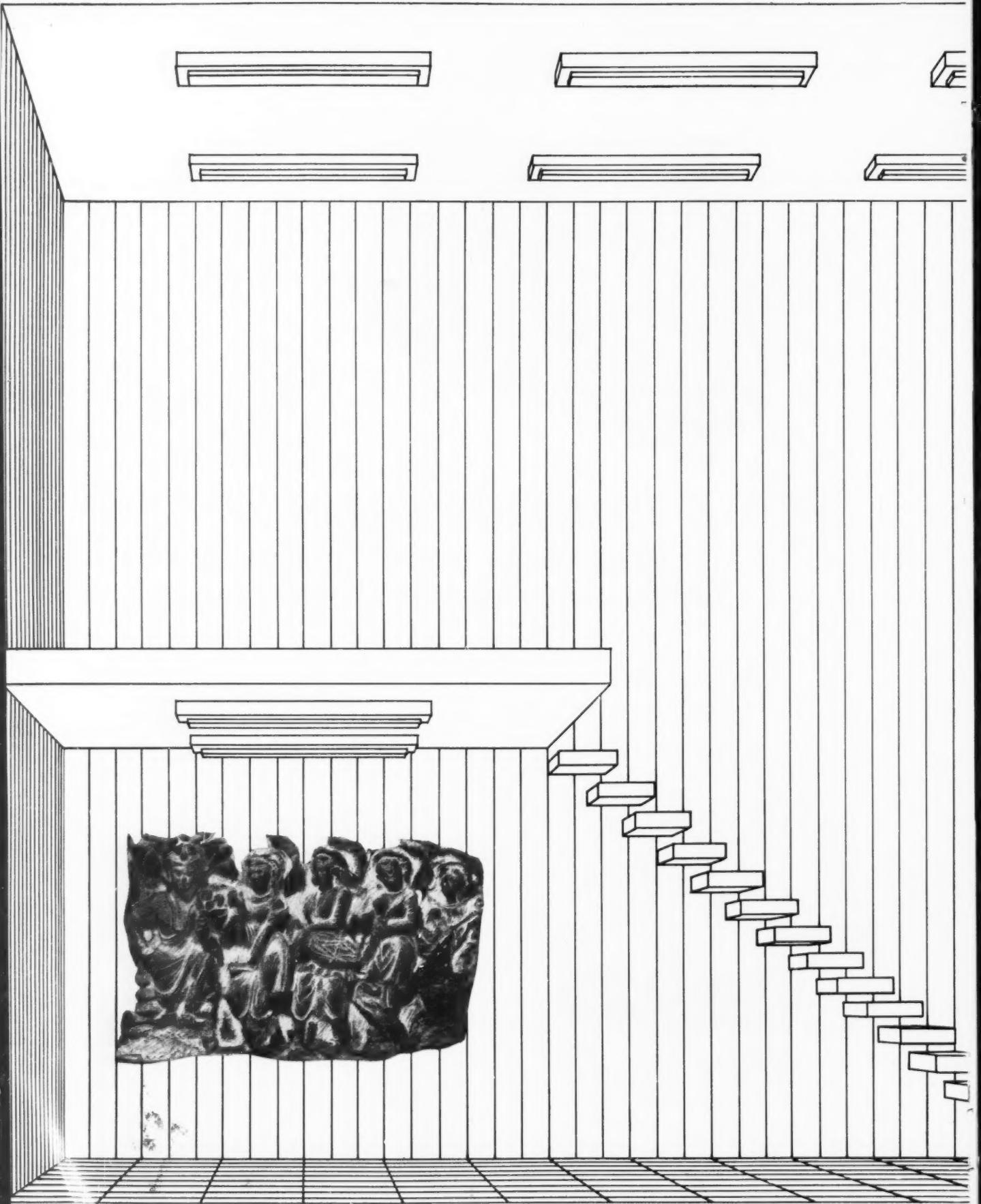
White Diesel

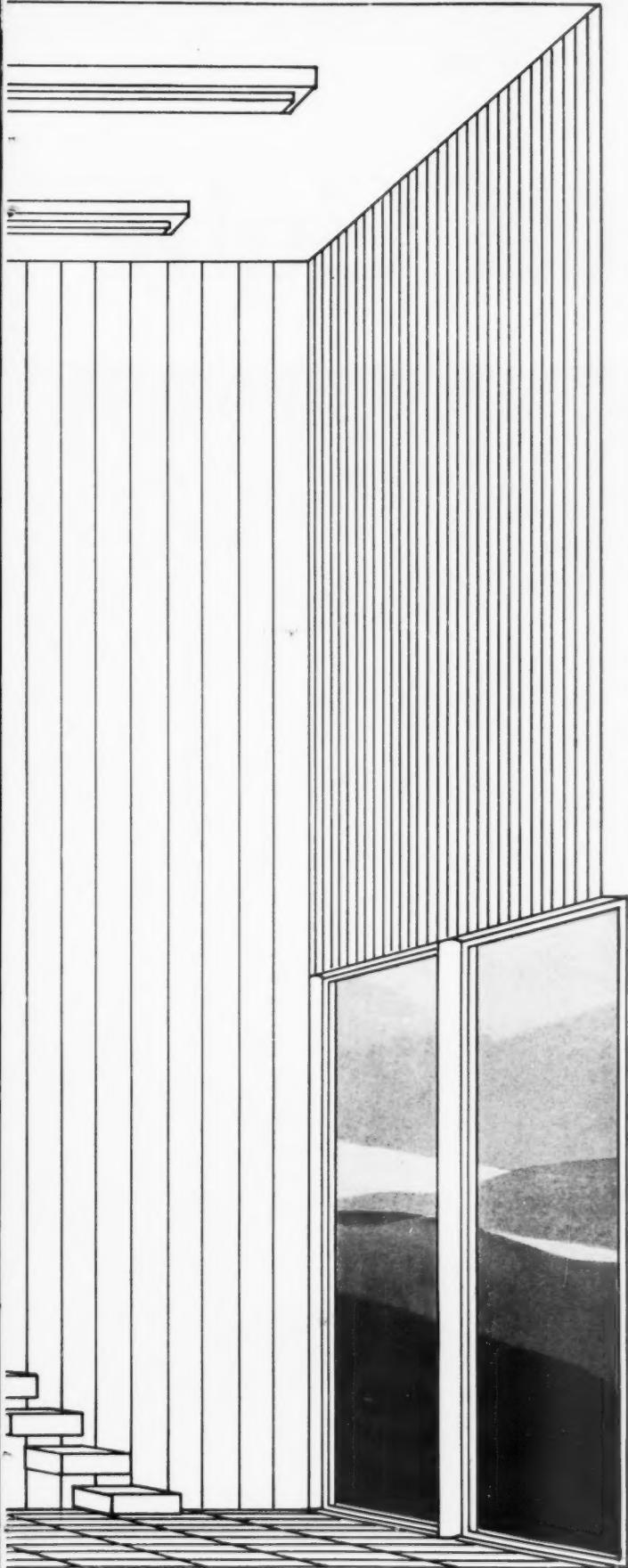
WHITE DIESEL ENGINE DIVISION
THE WHITE MOTOR COMPANY

Plant and General Offices: Springfield, Ohio



U.S. Air Force Photos





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and the surface gains in interest.
The interest turns to excitement
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Westinghouse fixtures
are the source of that light.
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part of the feeling
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Westinghouse Electric Corporation,
Lighting Division,
Edgewater Park, Cleveland, Ohio.
You can be sure . . . if it's Westinghouse.

J-04480

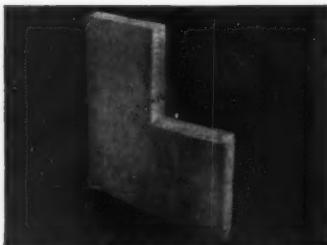
Westinghouse 

The room: a large mountainside living area.
The fixture: new Westinghouse SF luminaire.

THE STARTLING FACTS ON THE

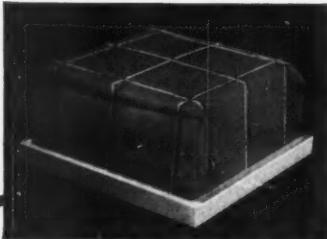
New ULOK Gube

BRAND



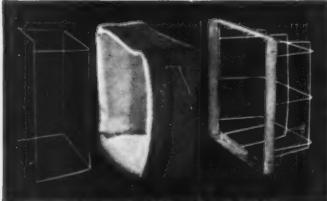
THE PERFECT FIBER!

UNION CARBIDE research has produced the truly ideal filter medium in DYNEL modacrylic fiber—a strong, high capacity fiber with an irregular, highly arresting cross section.



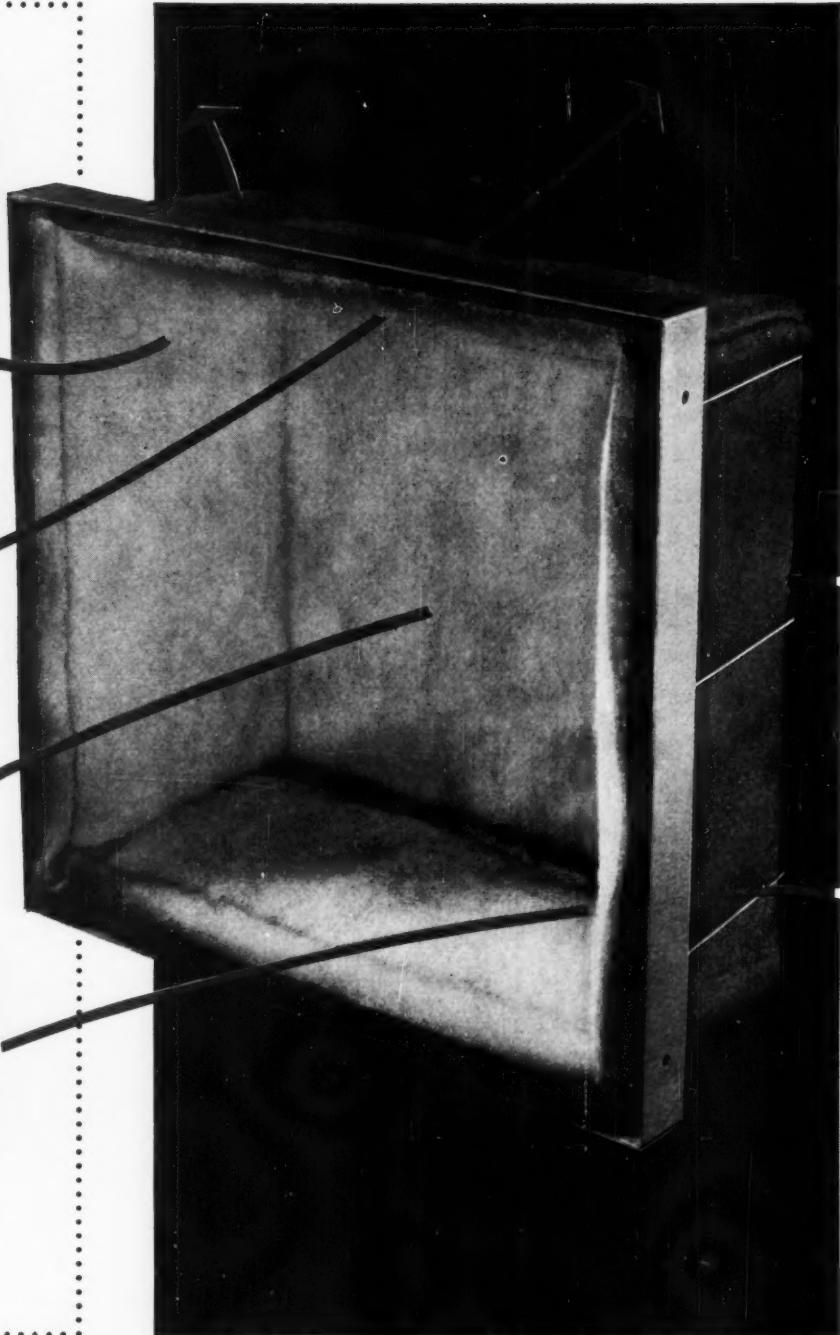
THE PERFECT FORM!

Basic component is a low density, three-dimensional batt, sewed into cube shape. Rust-proof retainer frame is inserted in batt, then batt is inserted in wire retaining basket. Final three-piece assembly is supported by holding frame within unit, is easy to handle—no sharp edges or "splinters". Easy to dispose of when full—simply collapse and discard ... the dust is in the bag!



THE PERFECT FIT!

Shape of retainer frame inside batt permits filter to seal itself in holding frame. Final filter assembly is a tight, leak-proof, press fit.



Type Air Filter:

New Filter Medium!

DYNEL filter medium stops and holds unusually large quantities of dirt. Self-sealing, leak-proof assembly completely eliminates problem of filter bypass . . . provides maximum economy at highly acceptable filtration levels.

Saves Change-Over Dollars!

ULOK Cube Filter lasts 6 times longer. Dirt is first trapped on inside face of filter. As dirt builds up, air flow is shunted to large filtering area of four sides. Thus, even after several pounds of dirt have been collected, high filtering efficiency and low pressure drop is maintained. This "reverse loading" process increases service life 6 times over that of conventional filters. Think of the savings in maintenance!

Uses Half The Space!

Medium-size ULOK Cube Filter has a filtering surface of 1040 sq. in.—140 more than a conventional 30" x 30" flat filter—yet it presents a frontal area of only 20" x 20". Filter bank area can thus be reduced by half with medium-depth filter, even more with deeper models.

At All Velocities!

ULOK Cube Type Air Filters afford the high filtering efficiency characteristic of low velocity units even in units employing air volumes as high as 1970 cfm!

Proved In Operation!

ULOK Cube Type Air Filters have been soundly proved in numerous installations. Reflecting a complete range of the filtering problems presented under varying operating conditions, these field trials were complemented by extensive and extremely severe laboratory tests.

Ideal for all commercial and industrial air conditioning, heating, and ventilating systems, ULOK Cube Type Air Filters are available in 12 sizes to meet any requirement.

WRITE TODAY FOR
FURTHER INFORMATION AND PRICES.



UNION CARBIDE DEVELOPMENT COMPANY

Division of Union Carbide Corporation

270 Park Avenue • New York 17, N.Y.

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From the Editor's

Tranquil Tower

The Johnson Theory of Profit

A. E. JOHNSON, Executive Secretary of the American Association of State Highway Officials, at the 39th Annual Conference of his organization, said, "I am unable to understand how the consultant can perform the services cheaper than the State if he furnishes the same level of service, since he must add promotion and profit items in his costs."

Mr. Johnson's position is one so rarely taken in public these days, and he has left himself so wide open from so many directions, that we hesitate to attack — not from want of arguments but from indecision as to which to use first. Actually, Mr. Johnson sounds more like something out of an 1890 Fabian Socialist tract, except that he seems so truly innocent that we are inclined to believe he was not merely intoning a trite phrase but really meant it when he said, "I am unable to understand . . ."

We do not have the space, nor is this the place, to lecture Mr. Johnson on the fundamentals of the economic system that is called Capitalism and is based on private ownership, competition, profit, and promotion. It should be enough to suggest to him that the best bargains he gets are the result of low prices brought about by competition and the profit motive — and the big sales at which he makes his best buys would be impossible if they were not promoted through advertising. It is the desire to make a profit and the use of wise promotion that combine to reduce prices.

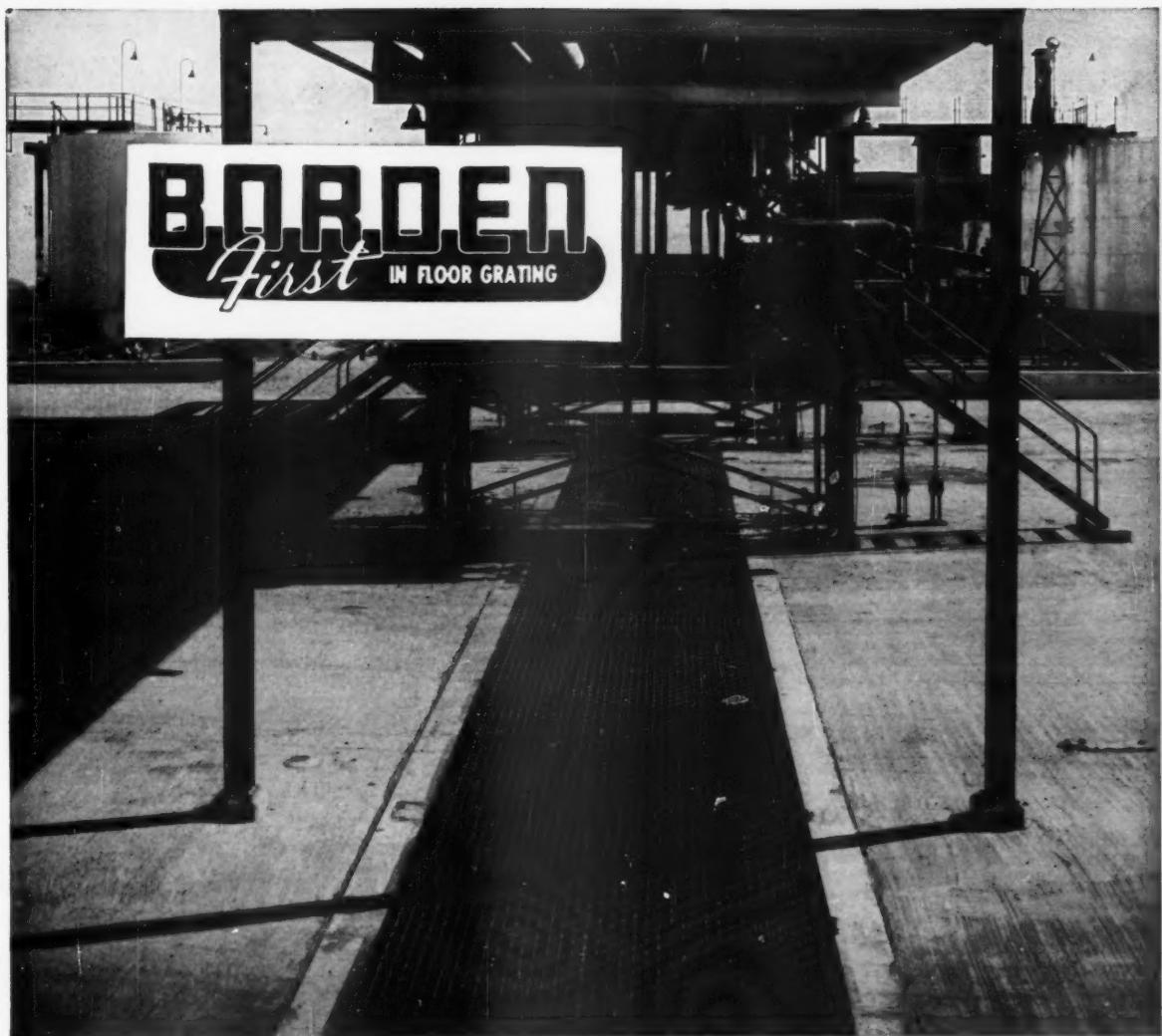
But if ours is not the task of educating A. E. Johnson, it is our job to warn state highway officials, consulting engineers, contractors, suppliers, and manufacturers — in short, all those groups represented in the American Road Builders' Association — that the American Association of State Highway Officials has as its Executive Secretary a man who frankly states that he cannot understand how private enterprise can do a job less expensively than the State, since a private businessman "must add promotion and profit items in his costs."

If this applies to the engineer in private practice, surely it must apply many times over to the contractors, the materials suppliers, and the manufacturers, for they, as pure private enterprises, depend solely upon profit for their existence and upon promotion for their sales. They must be much more guilty in Mr. Johnson's eyes than the consulting engineer, who is forbidden by his code of ethics to advertise and limited in his profit by fee schedules established by state highway engineers and other clients.

It is the contractors who are in the most immediate danger. Already some States are taking on construction here and there, and if Mr. Johnson's economic theories are followed, all construction will be done by the State using State owned equipment and State construction workers. As Mr. Johnson says, this would be less expensive, for there would be no profit and no promotion costs.

The same applies to the manufacturers and suppliers. If Johnson is right, the States also should handle the supply of materials and the manufacture of construction equipment of all types, thereby eliminating profit and promotion costs. This logically must be carried right back to the cement kilns, the steel mills, the rubber plants, the mines, and the farms, for all that profit and promotion ought to be eliminated, right back to the very source of the raw material. If the State cannot afford to pay for the profit and promotion in an engineering fee, it surely cannot afford to pay the many times greater profit and promotion costs that must, according to the Johnson theory, be included in material, equipment, and construction prices.

Unless Mr. Johnson looks upon engineering as a separate and uniquely evil aspect of the capitalistic economy, he must apply his economic beliefs to all private enterprise and call for the elimination of all profit and promotion. This would end private ownership — it would substitute "the State." □□



HERE'S HOW BORDEN FLOOR GRATING CUTS COSTLY FIELD CORRECTIONS . . .

Insures correct dimensions, fit, and placement . . .

1. A shop drawing of the job is submitted to the customer for approval, when necessary. This plan shows the size and shape of the grating area — how grating clears all obstructions.
2. Each finished panel is carefully checked for accuracy of dimensions.
3. Each panel is plainly marked with its number to insure quick, easy installation.
4. The entire platform is laid out on our shop floor. Overall dimensions and obstruction openings are checked against shop drawings.
5. Erection diagram showing panel mark numbers is supplied for field installation.

Write today for free
16-page catalog showing all basic types of grating;
more than 30 dimensional drawings of subtypes;
eight safe load tables for steel and aluminum grating.

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"Greatest name in gratings"

817 GREEN LANE ELIZABETH 2-6410 ELIZABETH, N.J.
Plants at: Union, N.J. — Leeds, Ala. — Conroe, Texas — Beeton, Ontario

BORDEN METAL PRODUCTS CO.

Gentlemen: Please send me NEW 1960 BORDEN Catalog

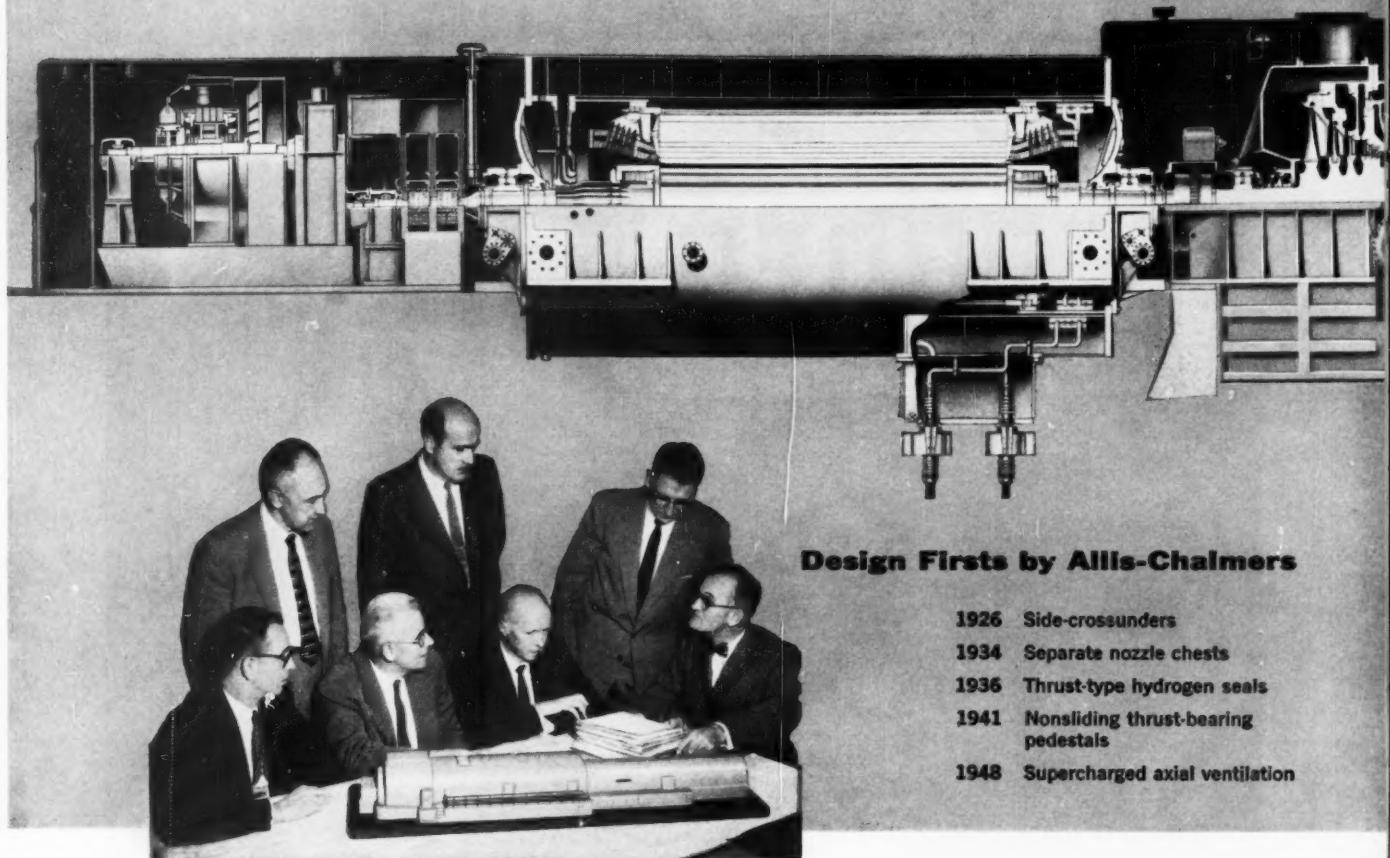
NAME _____

TITLE _____

COMPANY NAME _____

ST. AND NO. _____

CITY AND STATE _____

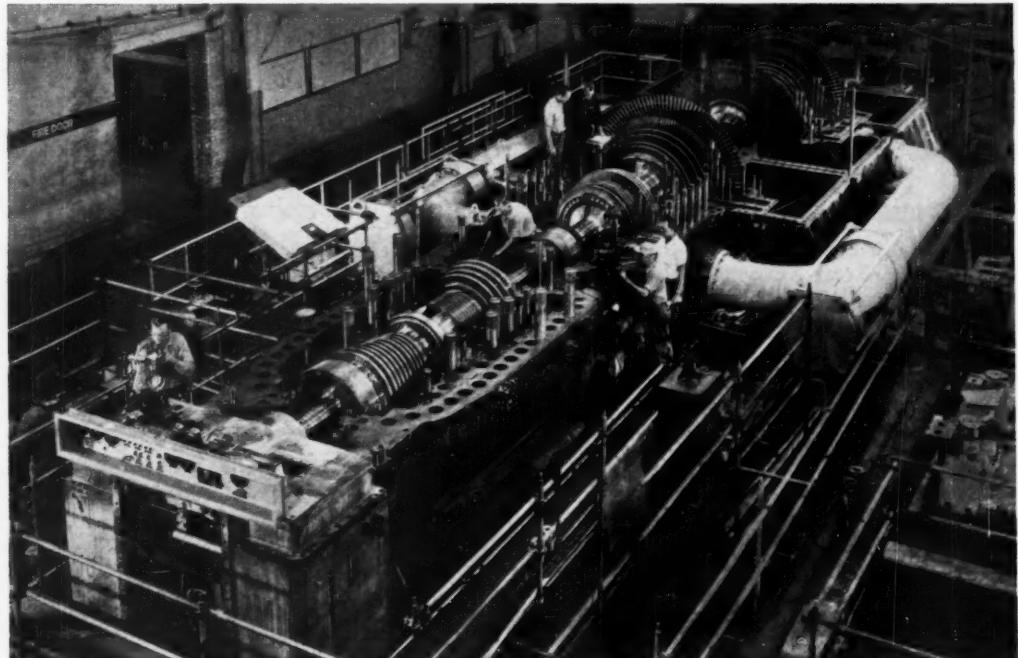


Design Firsts by Allis-Chalmers

- 1926 Side-crossunders**
- 1934 Separate nozzle chests**
- 1936 Thrust-type hydrogen seals**
- 1941 Nonsliding thrust-bearing pedestals**
- 1948 Supercharged axial ventilation**

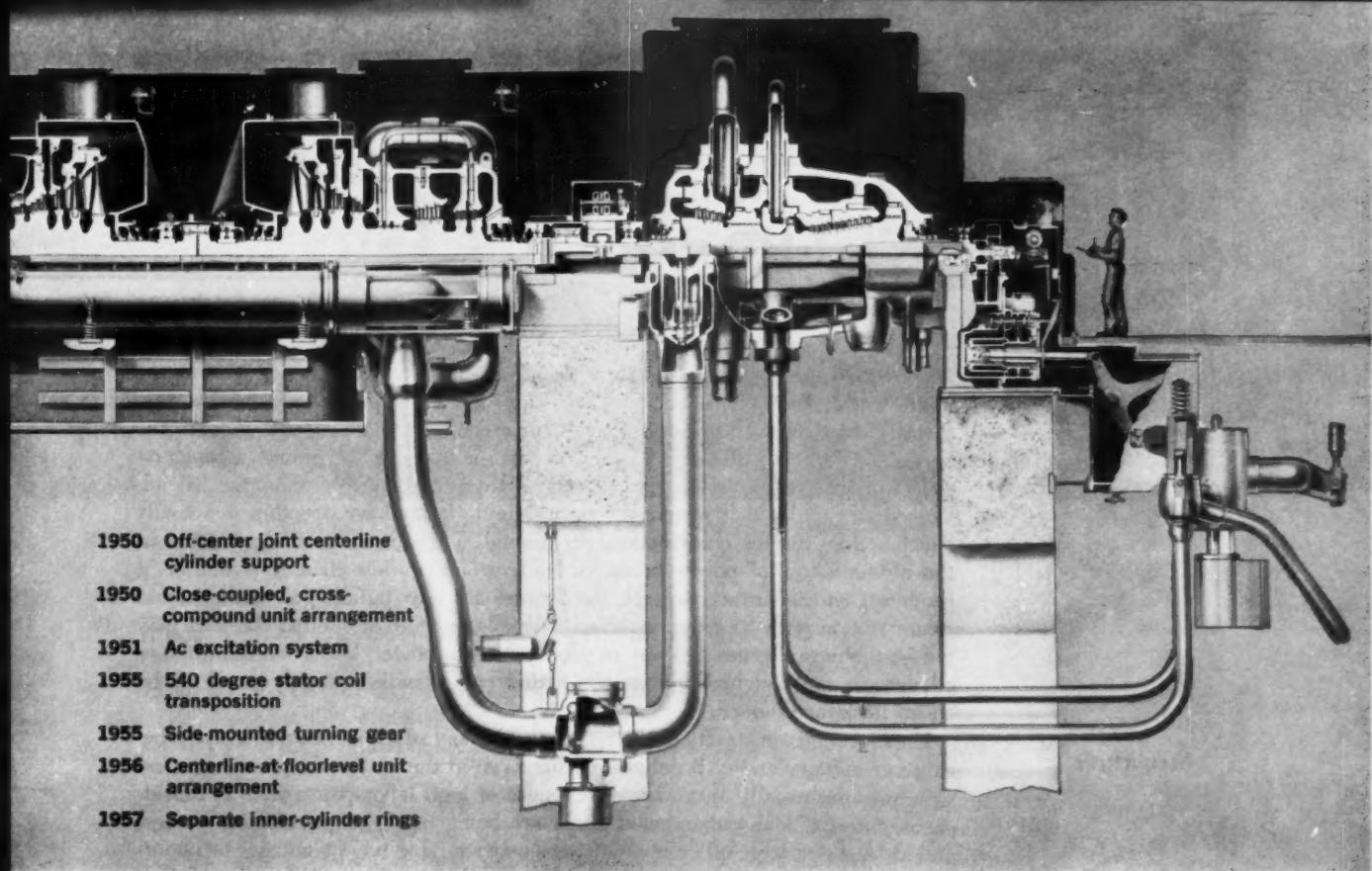
Designing today for tomorrow's power needs, Allis-Chalmers experienced, forward-thinking engineering staff has pioneered higher ratings and unique arrangements for steam turbine-generator units . . . originated and patented many of the design features now adopted as industry standards for such equipment.

PACING



Engineering know-how and the results of extensive research and development programs are confirmed on the large turbine test pits. During the past few years A-C has spent

millions of dollars expanding and modernizing manufacturing facilities like these to assure that design excellence created on the drawing board is translated into the finished product.



POWER PROGRESS

...by design!

An Allis-Chalmers tandem triple-flow steam turbine-generator unit, for example, incorporates such industry-recognized A-C developments as . . . centerline-supported inner and outer high-temperature cylinders; thrust-balanced turbine elements with high-temperature steam confined to a single shaft of small diameter; separate below-floor front-mounted steam chest; and separate ring-type nozzle chest in a center-inlet high-pressure turbine. Also, hydrostatic thrust-bearing-type shaft seals for the fully supercharged generator.

These advanced design concepts add to Allis-Chalmers growing list of firsts — set new industry standards for performance and continue the pattern by which A-C paces power progress . . . ahead of utility requirements.



NEW BULLETIN

For more information on these and other outstanding design features of Allis-Chalmers line of reheat steam turbine-generator units, contact your nearest A-C office for Bulletin 03B9448. Forty pages, illustrated by more than 100 photographs, tell how A-C is pacing power progress.



ALLIS-CHALMERS

A-1212



The Readers' Guide

Underground Structures *(page 98)*

Before 1946 there were only about 40 underground hydroelectric plants in the entire world. Today there are over 300 — and more coming. Most of these are in security conscious European countries, where memories of World War II die hard. Thus, it would be easy to assume that these plants were built without regard to cost — but nothing could be farther from the truth. Rock mining has advanced so rapidly that in many countries underground construction is actually cheaper than surface construction, or, through a combination of circumstances, the ultimate cost of power produced underground is less than it would be if produced on the surface. In fact, the Swedes are now building an underground steam station with six huge machine halls blasted out of solid rock. This may not be the most economical way to produce steam power, but when the military advantages are weighed against the added cost, it will probably prove to be cheap insurance indeed.

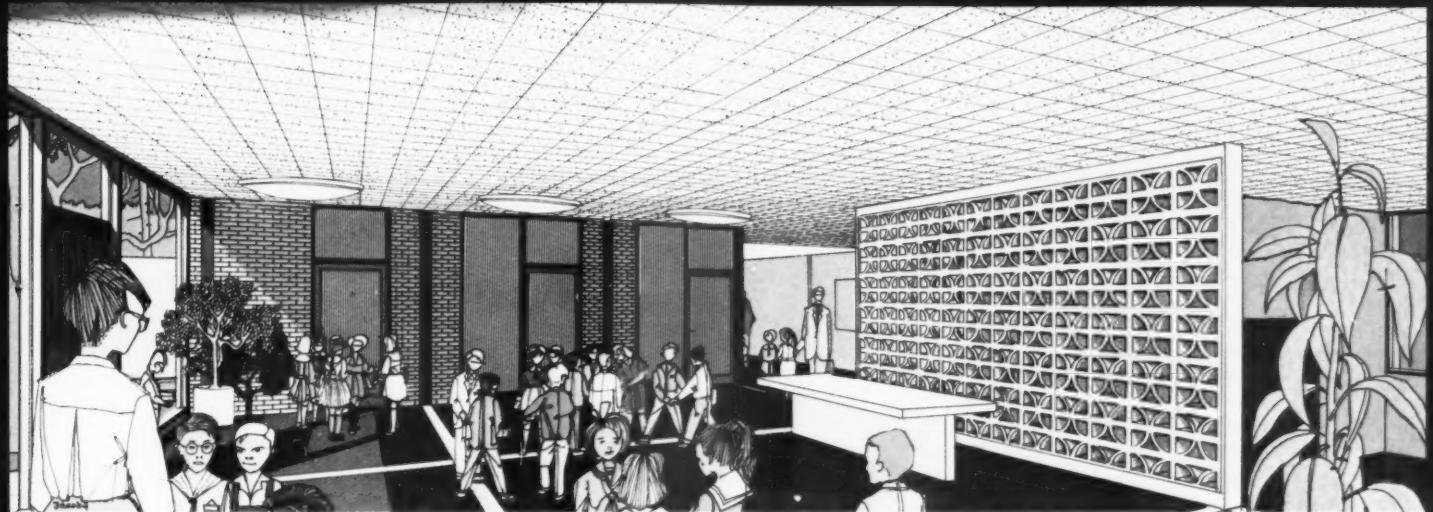
Underground construction is advancing on many other fronts, particularly because of military and civil defense needs. Even in the U. S., where underground structures are usually uneconomical because of high labor costs, there is considerable interest. Many abandoned mines are being used for government storage, and at least one large oil company is seriously studying the advantages of underground storage for consumer packaged seasonal products such as anti-freeze and light winter motor oils. Meanwhile, Norway and Sweden are burying their important industries in solid rock, and proving conclusively that the underground environment can be made just as attractive to the labor force as our most modern surface plants. The engineering aspects of underground structures present new and challenging problems, as indicated by the CONSULTING ENGINEER Special Staff Report beginning on page 98.

The only way to avoid mistakes is to assiduously cultivate the art of doing nothing, but the few consulting engineers who have tried that are broke. Having to do something, consulting engineers must, occasionally, make mistakes. And since their mistakes can be extremely costly in terms of both property and human life, they must be held to a minimum. The missing decimal point and the jumbled formula are near misses if discovered in time, but unforgiveable blunders if not. How to detect and eliminate mistakes is the subject of Robert Richards' article on page 128. He reminds us that the most obvious is the most often overlooked.

Noise Prevention *(page 94)*

Year round air conditioning, adjustable office partitions, high level lighting, and broad expanses of window wall are some of the conveniences of modern buildings that owners and renters have come to demand. It is unfortunate that with these conveniences has often come the distracting and disrupting influence of excessive noise — both internal and external. The modern building can be made acoustically acceptable, but too often it is done as an afterthought, when building tenants find the situation intolerable. The acoustics consultant has just as important a role in the design of the modern office building as he does in the design of a concert hall or the acoustical shell for an outdoor bandstand. The importance of preventing noise transmission, or at least reducing it below the level of disturbance, is the subject of Robert Newman's article on page 94.

How to Avoid Mistakes *(page 128)*



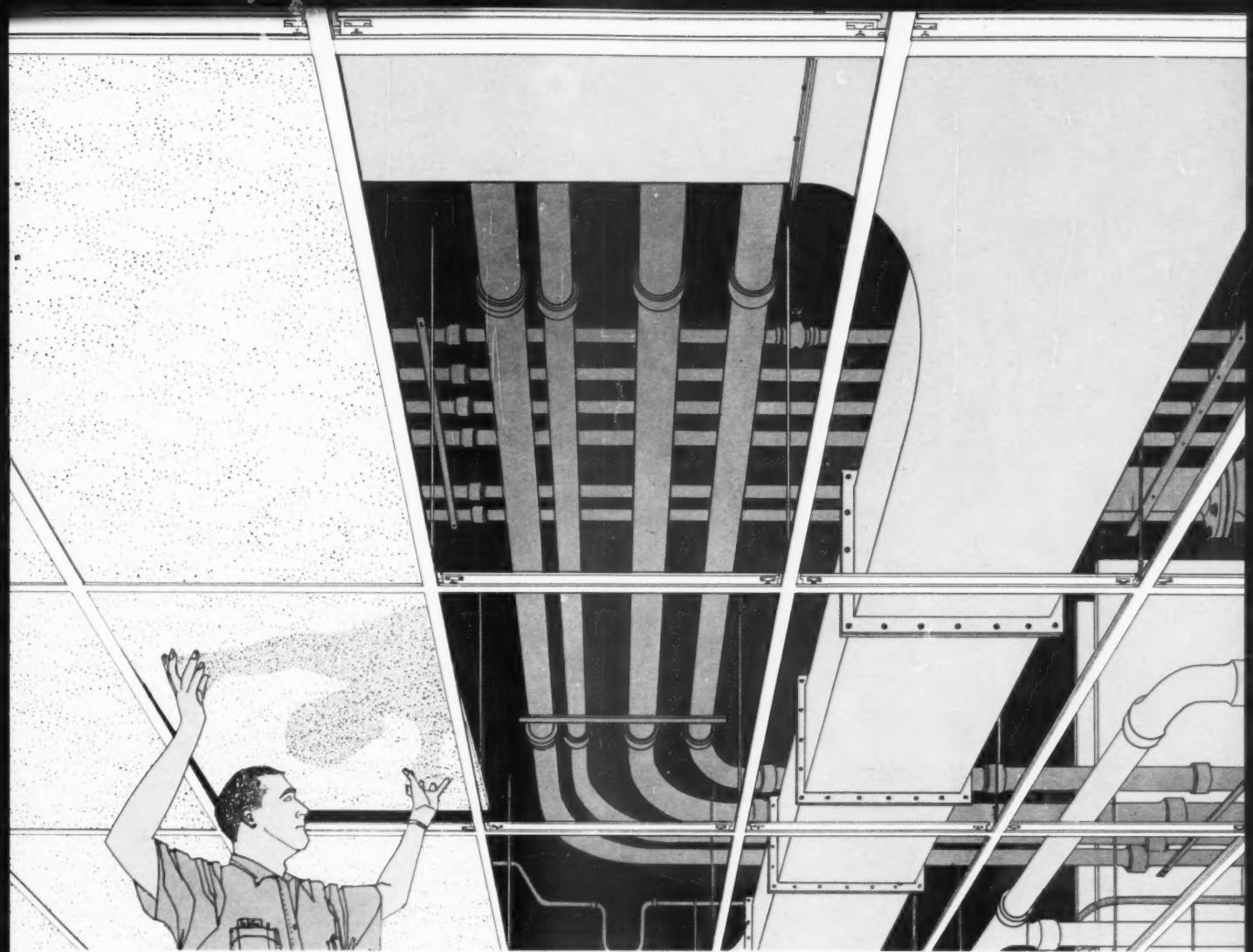
Centennial High School, Circle Pines, Minn. Architects: Ames-Crommett & Associates

Two years ago, Armstrong introduced
the first time-design-rated acoustical
ceiling tile—Acoustical Fire Guard. Today . . .

ARMSTRONG ANNOUNCES ANOTHER SIGNIFICANT DEVELOPMENT IN FIRE-RETARDANT CEILINGS



THE FIRST
AND ONLY
TIME-DESIGN-RATED
ACOUSTICAL LAY-IN
CEILING



Now there is no more economical way to get rated fire protection plus excellent acoustical qualities. It also offers the advantages of complete accessibility, dry installation, insurance savings, and beauty.

Once or twice in every decade, a company will develop a really new building product—a product that completely overhauls the industry's thinking. Two years ago, Armstrong did it with Acoustical Fire Guard tile. Since then, millions of feet of this tile have been installed.

Acoustical Fire Guard meets the nation's strictest fire codes and eliminates the need for costly intermediate protection between a suspended acoustical ceiling and steel structural members. It has saved builders up to six weeks' construction time and up to 30 cents per square foot construction cost.

The new Acoustical Fire Guard lay-in ceiling system goes a giant step further. It combines the advantages of the exposed grid suspension system (economy, fast installation, complete accessibility) with those of a time-design-rated ceiling.

THIS U.L.-APPROVED GRID CEILING SYSTEM PROTECTS STRUCTURAL STEEL FOR THREE HOURS

Underwriters' Laboratories, Inc., has given this revolutionary ceiling an official beam protection rating of three hours.

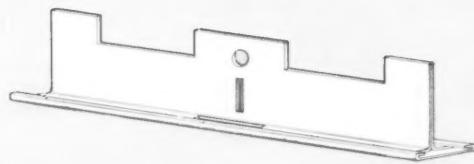
The unique composition of the Fire Guard lay-in unit enables it to maintain spanning strength, even when exposed to flames and 2000-degree heat for many hours. Ordinary acoustical ceiling boards virtually disintegrate under such exposure.

And the grid system is unique, too. Standard grid systems would buckle quickly in the heat of the test chamber. This buckling would drop the lay-in units, thus exposing the structural members to heat and flame. There is no buckling with the Acoustical Fire Guard exposed grid system. The reason: the expandable joints. (See diagrams.) Both the metal members and the lay-in units carry the U.L. Label.

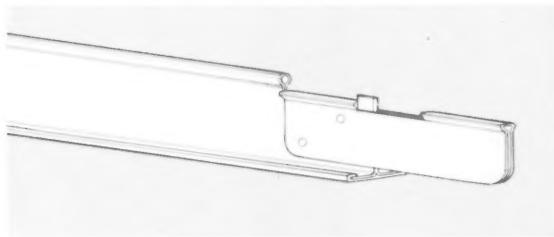
Like the familiar Acoustical Fire Guard tile, the new lay-in system protects the structural components of a building. It combines with a floor structure to help check the spread of fire by resisting the dangerous transmission of heat from one area to another.

In official U.L. tests, the new system—utilizing nominal 24" x 48" x $\frac{5}{8}$ " lay-in units—earned a beam protection rating of three hours. Assemblies using bar joist and slab as well as beam and steel floor construction earned official U.L. floor-ceiling ratings of two hours.

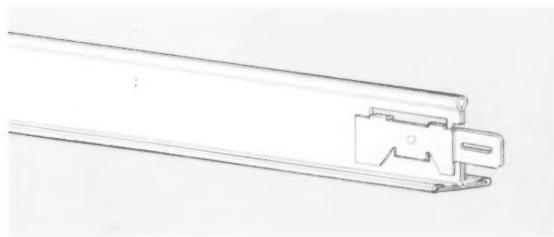
And in either the new lay-in system or in tiles, Acoustical Fire Guard may be used with a variety of construction forms to meet building code or insurance rating requirements. Variations from tested assemblies which maintain or improve the fire-retardant rating have been accepted by local code officials, building inspectors, and rating agencies.



Hanger splice

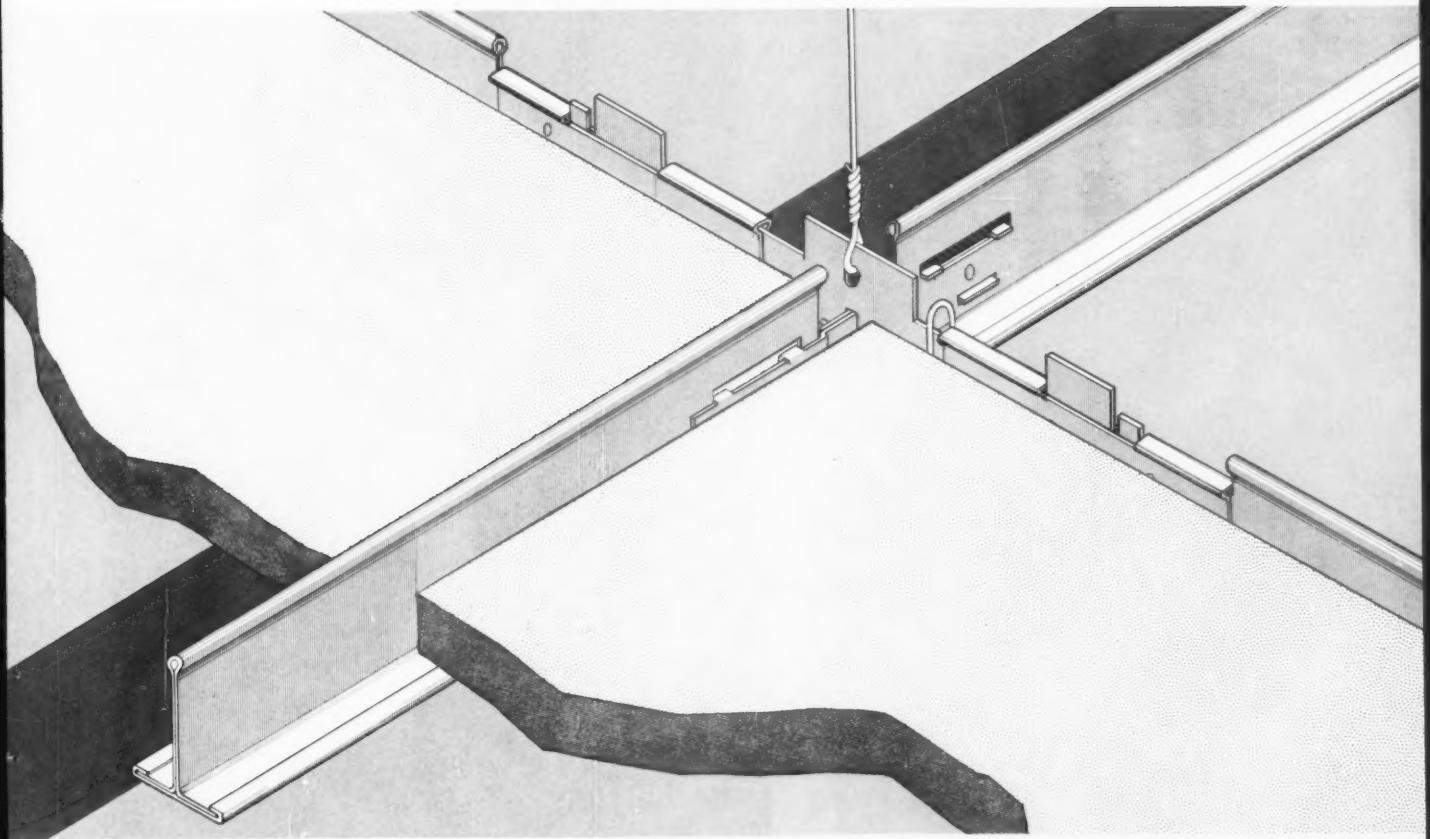


Main tee



Cross tee

Acoustical Fire Guard lay-in units can withstand 2000-degree heat for prolonged periods. The suspension system is designed to permit expansion of metal runners when exposed to intense heat and flame.



SAVE MONEY AND CONSTRUCTION TIME

Acoustical Fire Guard lay-in system reduces labor and material costs, insurance premiums, maintenance charges—and it speeds both new and remodeling projects.

Armstrong Acoustical Fire Guard lay-in ceilings are more economical than other finished ceilings that will provide two- or three-hour protection for structural steel. In most cases, they will cost even less than ordinary plaster ceilings on metal lath.

Not only is the cost of the units and the metal members low, but labor costs are lower because the large units are easy to handle and install.

Savings do not end with installation. Maintenance is minimized. Insurance companies recognize rated fire protection with lower premiums on a building and its contents.

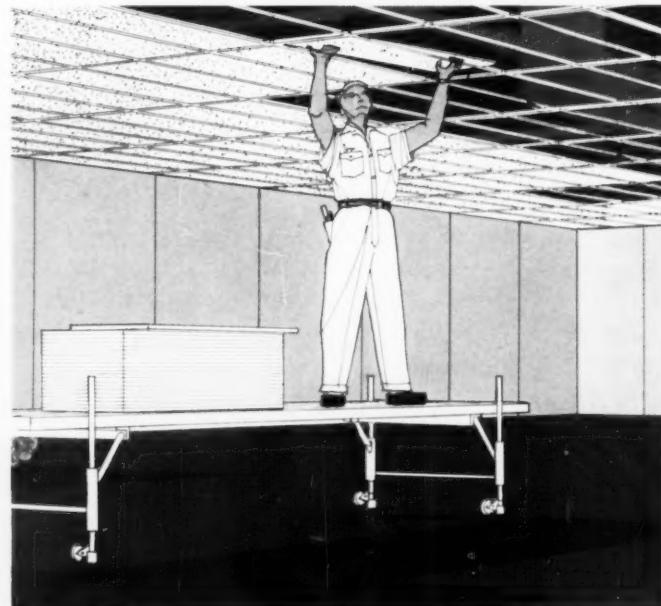
Because there is no messy wet operation which requires extensive cleanup, this product is ideal for remodeling jobs. Installation can be done during or after office or school hours. Stores continue to earn revenue during the installation.

Acoustical Fire Guard helps builders to meet deadlines in another way. Other trades (such as carpenters, flooring contractors, and painters) can be on the job at the same time as the acoustical contractor. There is no waiting for wet work to dry. This alone can save weeks. When combined with the other time-saving advantages of Armstrong Acoustical Fire Guard lay-in units, the saving can amount to *two months or more*.

Excellent for remodeling jobs



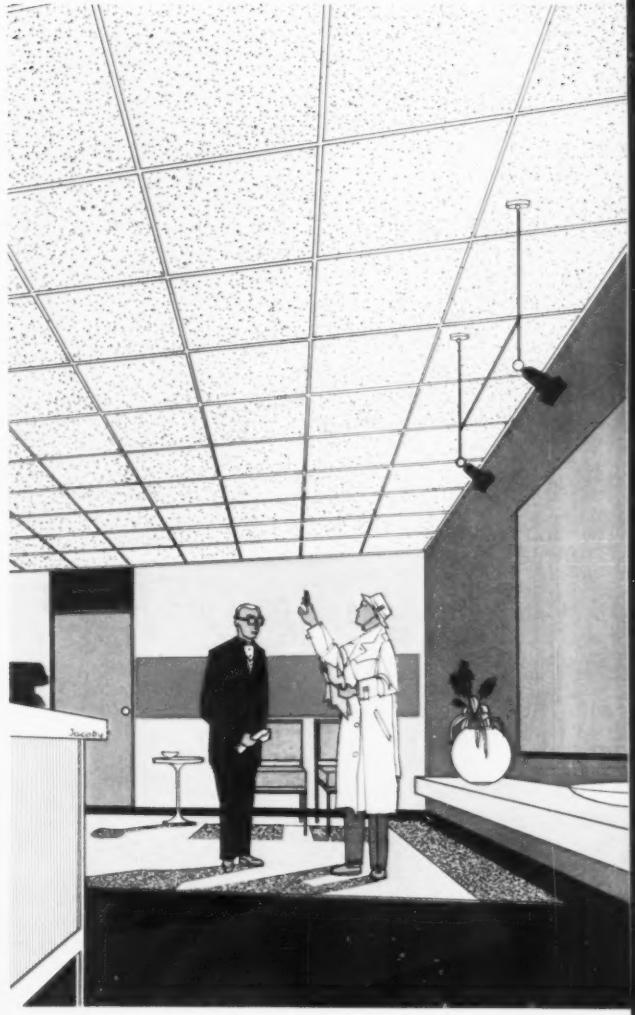
Large units go in fast and dry

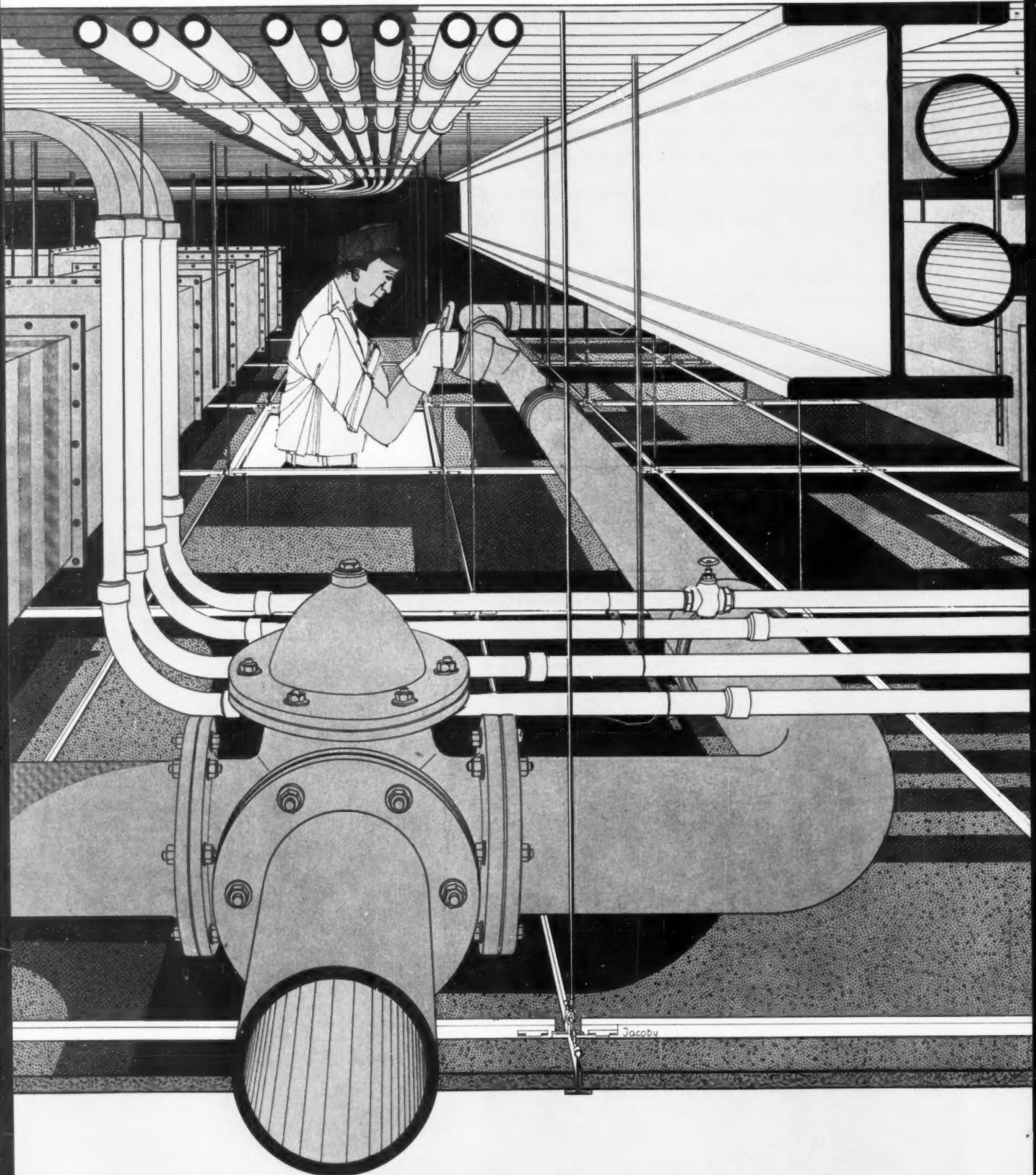


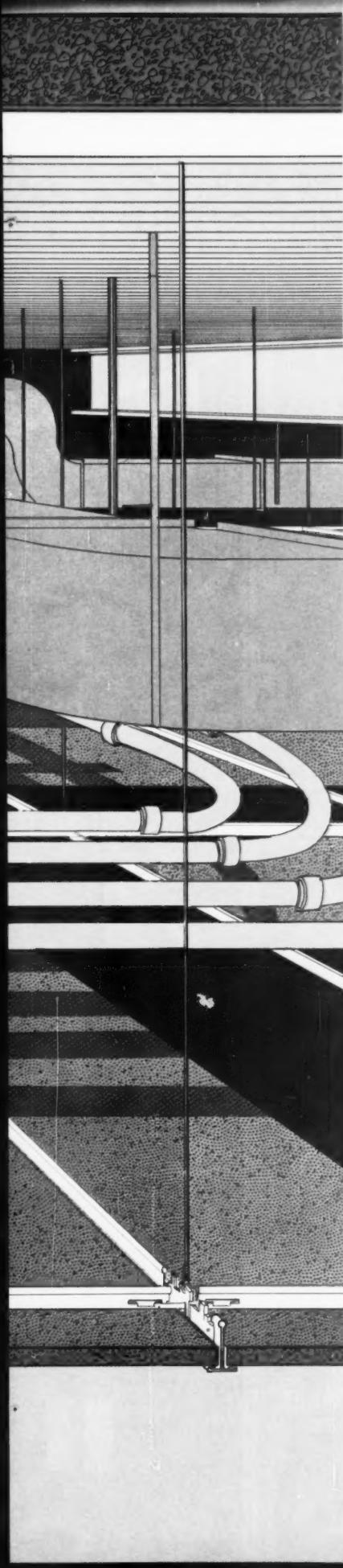
Other trades can be on the job



Protection cuts insurance rates







THE NEW ACOUSTICAL FIRE GUARD SYSTEM ALLOWS COMPLETE ACCESSIBILITY

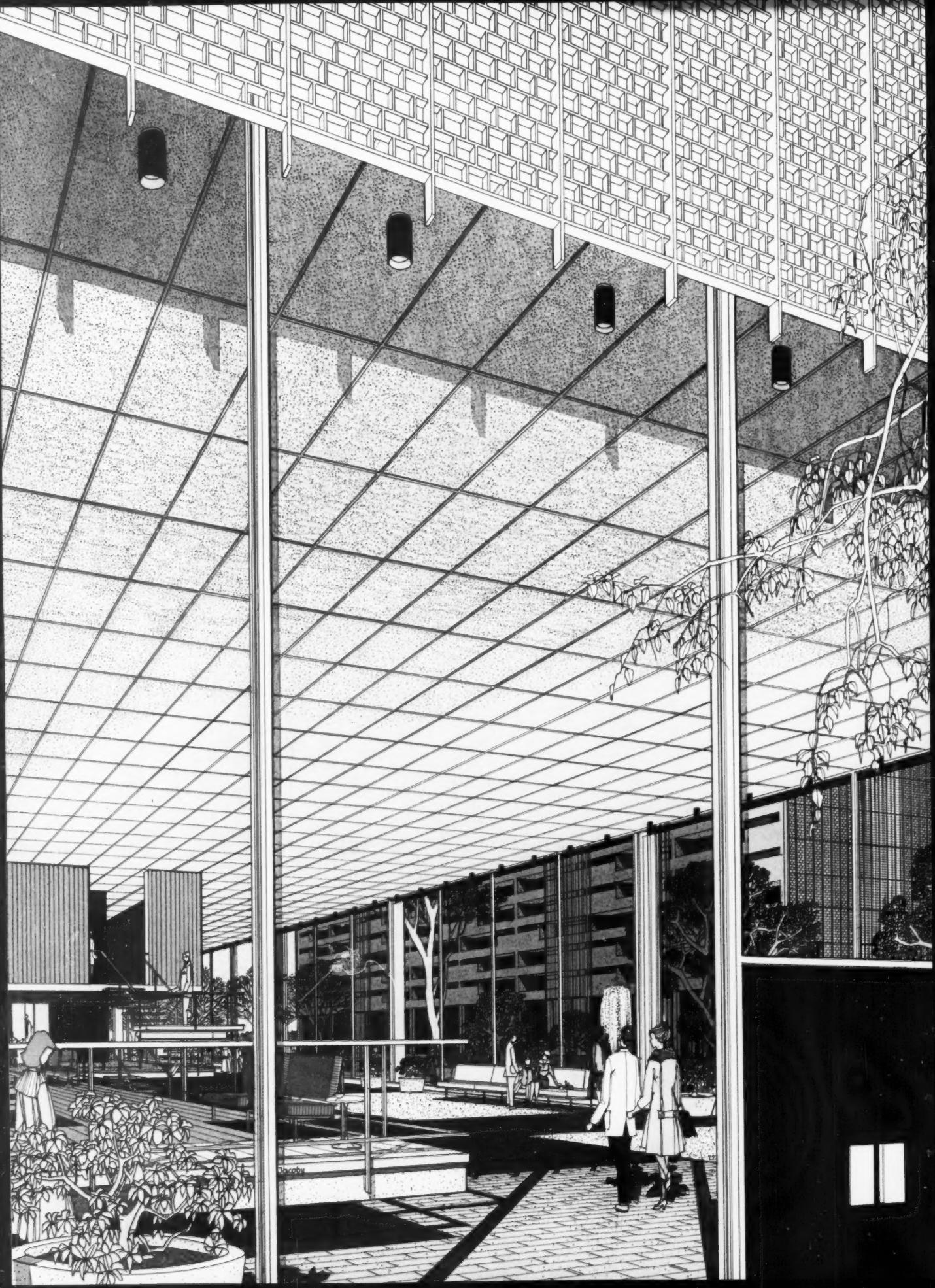
The Acoustical Fire Guard grid supports the panels on all four edges. The units can be lifted out for complete access to any part of the plenum chamber.

Because of the maze of pipes, ducts, and electrical equipment installed above the suspended ceilings of today's buildings, accessibility has become an important consideration in specifications. The only way to gain access through an old-fashioned plaster ceiling was by expensive access doors or by breaking through the ceiling when an emergency arose.

The Acoustical Fire Guard exposed grid system provides 100 per cent accessibility to the areas above the ceiling. Each panel is supported on all four edges. Every board can be lifted out in seconds.

The new Acoustical Fire Guard lay-in units are available in two nominal sizes: 24" x 24" and 24" x 48".

Lift out any units to afford immediate accessibility to the plenum chamber



BRINGS BEAUTY TO A BUILDING'S INTERIOR

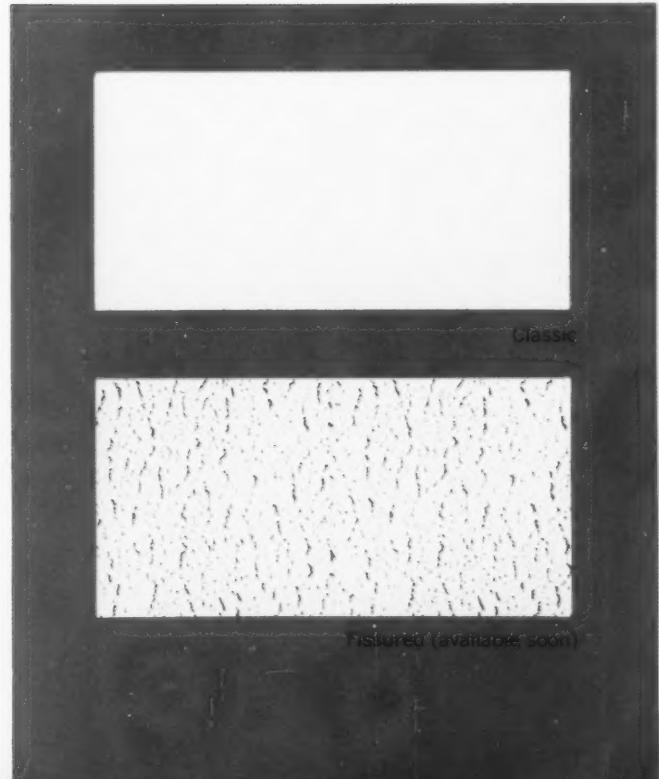
The room on the left has an Acoustical Fire Guard lay-in ceiling in the Classic design. The lace-like pattern of tiny perforations gives a smooth, free-flowing effect to the ceiling. Classic has been the most copied design in the history of the ceiling industry — ever since its introduction in 1958 by Armstrong.

Acoustical Fire Guard lay-in units will soon be available in the Fissured design. The attractive fissured surface is a traditional choice wherever ceiling appearance is a primary factor. The fissures resemble the look of travertine marble.

In addition to being an efficient sound absorber, Acoustical Fire Guard—because of its density and composition—can be used with ceiling-height partitions to minimize room-to-room sound transmission problems.

And Acoustical Fire Guard's white surface reflects light evenly, without glare. This ceiling has a light reflectance of "a" (over 75%). The exposed surface of the metal suspension members is available in two finishes—painted white, to match the ceiling boards, and anodized aluminum. Either finish contributes to a modern look for an interior.

Since the Classic and Fissured designs are identical in both the lay-in units and the tile, they can be combined in different areas of the same building.



SPECIFICATIONS FOR Armstrong ACOUSTICAL FIRE GUARD CEILINGS

JOB CONDITIONS

Acoustical materials shall be installed under conditions as outlined in the current bulletin of the Acoustical Materials Association.

SPECIAL CONDITIONS

Armstrong Acoustical Fire Guard shall be installed only by an approved Armstrong acoustical contractor.

MATERIALS

- a. Acoustical ceilings shall provide (one, two, three) hours' protection for structural steel as rated by Underwriters' Laboratories, Inc.
- b. Acoustical contractor shall submit, as a part of his bid proposal, written substantiation of the rating from Underwriters' Laboratories, Inc.
- c. Acoustical lay-in units where specified shall be nominal (24" x 48", 24" x 24") x $\frac{5}{8}$ " in size. Acoustical tile where specified shall be 12" x 12" x $\frac{5}{8}$ " in size with interlocking and self-leveling tongue-and-groove edges on four sides. Acoustical units shall have a factory-applied washable white finish with a light reflectance of "a" (over 75%). Acoustical units shall be provided in the following surface detail:
 - Armstrong Fissured Acoustical Fire Guard—Federal Specifications SS-A-118b, Type III, Class A (Incombustible)—Carrying Underwriters' Laboratories, Inc., Label for Fire-Retardant Classification.
 - Armstrong Classic Acoustical Fire Guard—Federal Specifica-

tions SS-A-118b, Type IIB, Class A (Incombustible)—Carrying Underwriters' Laboratories, Inc., Label for Fire-Retardant Classification.

- d. When acoustical lay-in units are specified, suspension system shall be Armstrong Acoustical Fire Guard exposed grid system as shown in the Underwriters' Laboratories listing of the time-design-rated ceilings. Suspension members shall be finished in (white, anodized aluminum) and shall be of the proper dimension to support the size of Fire Guard lay-in units specified. Suspension system shall carry U.L. Inc., Label for Fire Retardant Classification. Where acoustical tiles are specified, suspension system shall be concealed zee system.

INSTALLATION

- a. Installation of suspension system. The acoustical contractor shall furnish and install (Armstrong Acoustical Fire Guard exposed grid system, concealed zee system). The system shall be installed in the pattern as shown on the drawings. The system shall be installed in strict accord with the manufacturer's recommendation and in such a manner as to achieve the specified fire-retardant time-design rating. System shall be installed to permit border units of greatest possible size.
- b. Installation of acoustical material. The acoustical contractor shall install Armstrong Acoustical Fire Guard in the types, sizes, and surface designs specified above or in the drawings. The acoustical units shall be installed in strict accord with the manufacturer's recommendations and in such manner as to achieve the specified fire-retardant time-design rating.

NOTE:

Complete specifications and detailed working drawings are available from your Armstrong representative or your approved Armstrong acoustical contractor.

Armstrong District Offices

ATLANTA 8, GA.
727 West Peachtree St., N. E.

BOSTON, MASS.
200 First Avenue,
New England Industrial Center,
Needham Heights 94

CHARLOTTE 3, N.C.
1127 East Morehead Street

CHICAGO 34, ILL.
6535 West Irving Park Road

CINCINNATI 37, OHIO
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321 Lafayette Avenue, West

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1814 Ogden Drive,
Burlingame, Calif.

SEATTLE 9, WASH.
221 Minor Avenue, North

CANADA
6911 Decarie Boulevard,
Montreal 29, Quebec



Heard Around Headquarters

MARJORIE ODEN,
Eastern Editor

Government Lauds Consultants

A new brochure put out by the Urban Renewal Administration — "Selecting Consultants for Project Planning" — does an excellent job of public relations for the consulting engineer. (CONSULTING ENGINEER, Oct. 60, p182.) The publication is available from the Superintendent of Documents, Washington, D.C., at \$0.25 a copy.

It starts off pointing out that "most communities find it more feasible to secure the services of a consultant firm to handle specialized phases or all of the project planning job." Then: "No two consultant firms are alike; contact several before narrowing the field to those which appear to be most suitable. If you are considering those known to be doing work of the same type in other communities, find out whether or not their working relationship and service have been satisfactory.

"Be selective in developing a list of consultants to contact. Don't make the mistake of contacting too many firms. This can prove time-consuming and unproductive — for both local officials and the consultants involved."

Even more to the point, it adds: "The fee paid the consultant is a minor part of the project cost, but the skill of his staff and the quality of his services can be a major factor in project success. Even

though skills and experience, and not the fee, should govern consultant selection, the LPA (Local Public Agency) needs to know early in the game what the approximate fee will be to consider it along with the other factors.

"The Housing and Home Finance Agency does not require nor recommend that an LPA obtain professional consultant services on the basis of competitive bidding. Many professional societies prohibit their members from engaging in competitive bidding. An LPA should be free to select its consultants on the basis of their reputation, competence, and their ability to perform the desired services within a reasonable time schedule."

And it concludes . . . "Be prepared to work with your consultant, if you expect to receive the full value of his services.

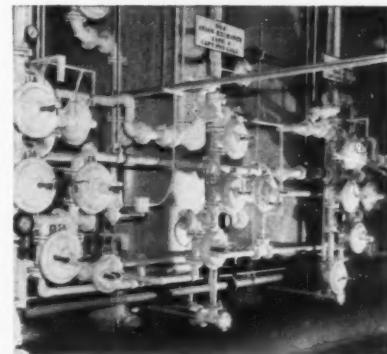
"Give him guidance on local conditions, broad community objectives for urban renewal and specific ideas on what the project ought to be, but don't fence him in. He should have ample opportunity to improve on existing ideas or come up with some new ones. Give him room to exercise his professional judgment; this is what you're paying for."

How to Lobby

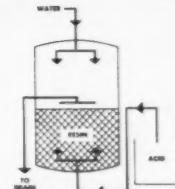
Instead of merely telling members to take an active part in legislative activities in their home states, the

HIRAM WALKER

uses...



Right, a diagram of the IWT Counterflow* system of regeneration, whereby a downward flow produces a "barrier" to keep the bed from being expanded by the upward flow of regenerant.



DISSOLVED SOLIDS IN RAW WATER REDUCED FROM 570 TO 3 PPM USING "COUNTERFLOW"

At the Hiram Walker distillery in Peoria, Illinois, the IWT equipment shown above is used to provide purified water for adjusting proof of various alcoholic beverages. It consists of automatic Counterflow* cation exchangers, automatic weakly-basic anion exchangers, and a vacuum degasser. The de-ionized water is suitable for beverage use without any need for activated carbon filtration, because the resins used do not add any taste, color, or odor to the water. The equipment, after 2½ years, is still giving rated capacity of 140,000 gallons in each 24 hours. Quality, proposed at 5 ppm, actually runs mostly at 1 ppm with a maximum of 3 ppm. Counterflow* regeneration provides lowest operating cost through reduced regenerant dosages.

* U.S. Pat. 2,891,007

IWT LEADS THE WAY

The experience which enabled IWT to produce this excellent performance at Hiram Walker has been gained through intensive pioneering in the important phases of the ion-exchange process ever since its introduction in 1937.

ILLINOIS WATER TREATMENT CO.
1840 CEDAR ST., ROCKFORD, ILLINOIS
NEW YORK OFFICE: 141 E. 44th St., New York 17, N.Y.
CANADIAN DIST.: Pumps & Softeners, Ltd., London, Ont.

National Society of Professional Engineers has a committee preparing a guide to show members effective ways to get bills passed.

"With a new Model Law under consideration by NSPE and other engineering societies, we are probably about to experience a wave of proposed new engineering legislation in several states. The effectiveness of our state societies in promoting new state legislation varies widely throughout the coun-

try . . . even the more experienced can often learn from the successes of the novices," the committee observed.

Headquarters Change-Over

Closing of the \$1.5 million sale of the old Engineering Headquarters Building in New York City's wholesale hat district has been set for mid-January. The building, which always looked like a police precinct station, is tentatively sched-

uled by the new owners, Develop Realty Corporation, as a Textile Center. The basement, the main floor, and the second story would become a Health Club complete with swimming pool, steam rooms, and gymnasium. The auditorium, full of echoes of technical discussions, will be the site of fashion shows and showrooms.

Meanwhile, plans have been announced for the opening of the new headquarters building:

¶ First and second floors — lobby and exhibition space.

¶ Third floor — United Engineering Trustees, Inc., Engineering Foundation, Engineers Joint Council, Society of Women Engineers, American Institute of Consulting Engineers, Engineers Council for Professional Development, and Municipal Engineers of the City of New York.

¶ Fourth floor — American Institute of Industrial Engineers and the American Society of Heating, Refrigerating, and Air-Conditioning Engineers.

¶ Fifth, sixth, and seventh floors — American Society of Mechanical Engineers.

¶ Eighth floor — Welding Research Council and the American Welding Society.

¶ Ninth floor — Illuminating Engineering Society and the American Institute of Electrical Engineers.

¶ Tenth and eleventh floors — American Institute of Electrical Engineers.

¶ Twelfth floor — American Institute of Chemical Engineers.

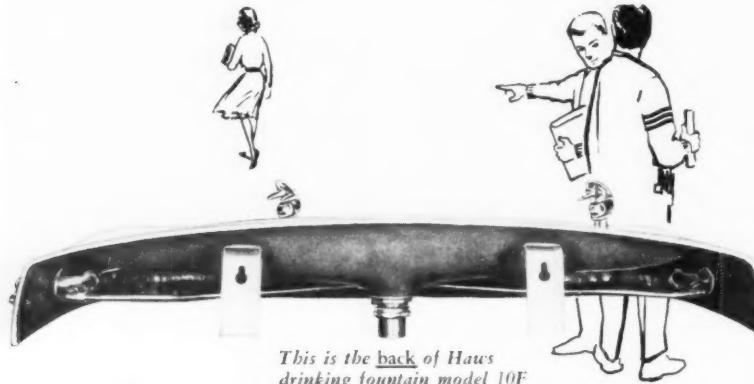
¶ Thirteenth and fourteenth floors — American Institute of Mining, Metallurgical and Petroleum Engineers.

¶ Fifteenth and sixteenth floors — American Society of Civil Engineers.

¶ Nineteenth and twentieth floors — mechanical equipment.

Act on Amaigamation

The Engineers Council for Professional Development, at its recent convention in Montreal, voted to



This is the back of Haws drinking fountain model 10F

Look at the Back for a change!

From the front Model 10F is a beauty in colorful fiberglass — but it is HAWS unseen quality that truly backs it up. Careful craftsmanship is from the inside out! This dual-bubbler model, heat and pressure laminated with reinforced fiberglass, has hidden features: exclusive flow controls, vandal proof accessories, easy-to-use wall hangers and overall strength.

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As the passer-by sees it, Haws Model 10F has all the styling distinction that makes HAWS the unanimous choice for beauty. Specification sheets will be sent on request — or write for the complete HAWS 1961 Catalog.



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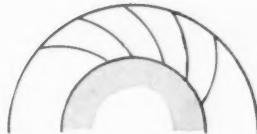
- **High efficiency over a broad range of operation** — ideal for supplying ventilation and air conditioning systems.
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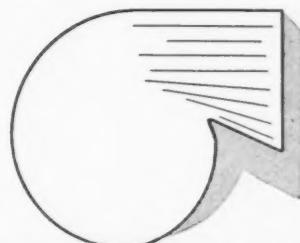
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Cross-section of inlet, showing smooth half-circle passage into wheel formed by curved inlet bell and mating wheel flange. There are no flat spots to cause turbulence.



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send member organizations the proposal for amalgamation of ECPD and Engineers Joint Council. It will take a two-thirds majority for ECPD to act. The proposed amalgamation, first discussed last year, has been delayed until EJC gets its new tax classification.

Also at the Montreal meeting, engineering courses were accredited at the University of Puerto Rico (civil, electrical, mechanical); the University of Florida (civil);

Fairleigh Dickinson in Teaneck, New Jersey (electrical); and Brigham Young University in Provo, Utah (civil, electrical, and mechanical).

Eternal Revenue Question

Engineers Joint Council recently held an "informal discussion" with the Bureau of Internal Revenue regarding a new tax classification. The tax men want to know about all the activities of EJC, and EJC

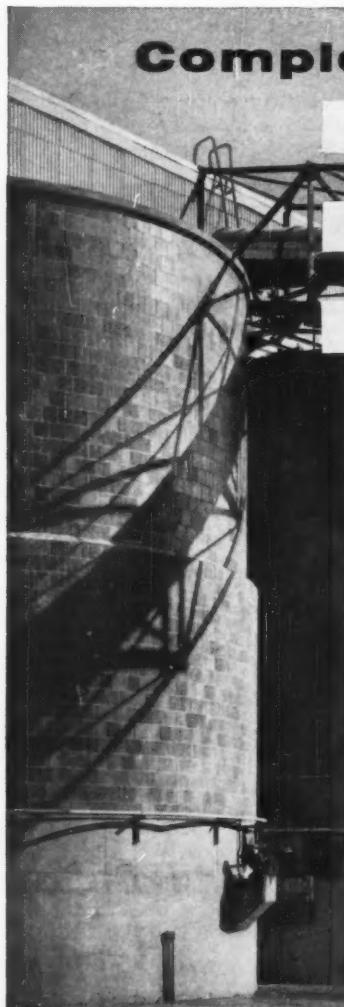
has one month in which to prepare a written resume of same. EJC spokesmen are "optimistic."

Education South of the Border

At a recent educational conference in Buenos Aires, it was pointed out that there is a wide variation in the qualifications of engineers turned out by schools in Latin America. As a result, the Pan-American Federation of Engineering Societies (UPADI) hopes to make a comparative study of the engineering educational standards and systems in South America. The study will help establish a basis for world comparison of engineering standards, and will help foundations and governments decide which areas are most in need of immediate assistance.

NSPE On Corporate Practice

The National Society of Professional Engineers has approved the chapter of the revised Model Law dealing with corporate practice. (See "Field Notes," this issue.) The Registration Committee, in recommending approval of the corporate practice provision, pointed out that "The most controversial section of this guide has been 22(d), which attempts to deal with the corporate structures. Opposition to it seems to have emanated principally from engineers in private practice. We feel that we should not have first-and-second class engineers. We feel that every engineer, regardless of where he works, be it for the Federal Government, the state, county or local governments, public utilities, manufacturers, or any place where the public welfare or the safe-guarding of life, health, or property is involved or concerned, should be a registered and licensed engineer . . . To propose that a corporation using the services of professional engineers must have a majority of the directors . . . and a majority of the officers . . . registered professional engineers is simply unrealistic. It cannot possibly apply



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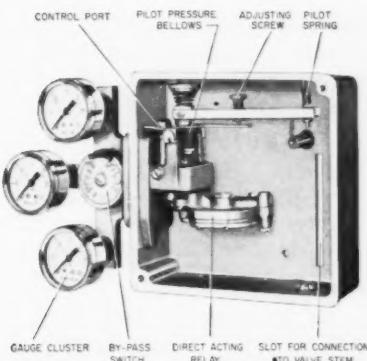
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to any corporation except one which has been set up for offering engineering services to the public."

Diversification Fever

A few changes have been made by New York City engineering corporations recently, in the name of diversification.

Burns & Roe, engineers and constructors, has formed a construction company, Burns & Roe Construction Corporation. In addition, Burns & Roe and Clinton B. F. Brill now are joint owners of Brill Engineering Corporation, which will engage in a broad spectrum of engineering activities.

Electric Bond & Share Company, which already owns Chemical Construction Company and Ebasco, has acquired another subsidiary — Walter Kidde Constructors, Inc. This now gives Electric Bond & Share specialty firms in chemical, utility, and industrial design and construction.

Engineering Books Needed

The recent severe earth tremors in South America destroyed, among other things, \$5 million worth of buildings and equipment at the engineering school of the University de Concepcion, in Santiago, Chile. The school is trying to rebuild its lost library, and urgently needs any mechanical or chemical engineering books that American engineers can spare. The request was forwarded through the American Institute of Chemical Engineers office in New York.

Dilemma of the Month

The General Accounting Office was a little upset at one of its findings in a study of Oregon and Montana Federal Aid Highway projects. Seems the GAO found someone had scheduled a highway through the middle of a proposed reservoir. The GAO added that Bureau of Public Roads officials were taking corrective measures. Designing a bridge, maybe? □

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The new issue of Code for Pressure Piping ASA B31.3-1959, for example, allows a *design pressure* of 611 psi for 2" ips Schedule 5, Type 304L process pipe at 100°F. Under the same conditions, allowable design pressure for 1½" ips pipe would be 768 psi; for 1" ips, 1122 psi.

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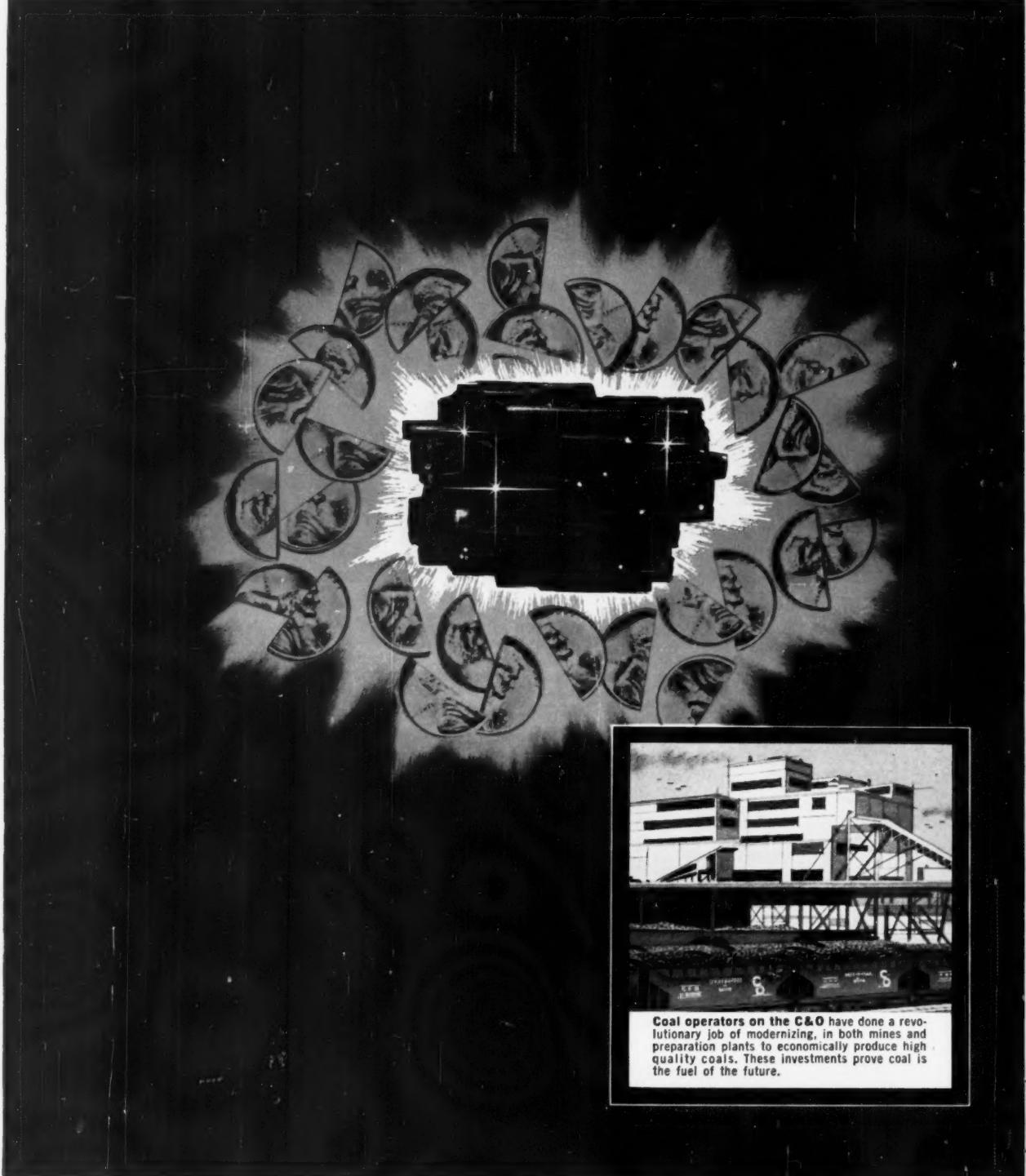
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Coal, for these reasons, remains the wise choice in fuel... for industry... for small businesses and commercial establishments... for institutions. It is the low-cost, high efficiency fuel, and *it's here in abundance!*

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JOB REPORT: NELSON Stud Shear Connectors in Composite Construction

COMPOSITE STEEL-CONCRETE CONSTRUCTION...

in the new Pfizer Medical Research Laboratories

Composite construction saved 20% on steel tonnage in this modern three-story research facility which consolidates many scientific disciplines in the search for new drugs to advance better health and lengthen man's life span. According to consulting structural engineers, Garfinkel and Marenberg, by using lighter, shallower steel beams, more space was provided for the passage of piping and duct work, while minimum depth of floor construction was maintained.

Nelson stud shear connectors were welded to the top flanges of the steel floor beams and were then embedded in the concrete floor slab. Once the concrete set, the shear connectors transferred horizontal shearing forces from the beam to the concrete slab...causing the concrete and steel elements to function as a unit.

Composite construction can provide these economies and advantages for your next job... shallower beams to meet equal load requirements • provide the same usable cubic area with less building materials • longer spans for greater load-carrying capacity per pound of steel • wider spacing of columns for more unobstructed floor space.

For complete information, call in your local Nelson Field Man, or write for "Composite Construction for Buildings", Nelson Stud Welding, Division of GREGORY INDUSTRIES, INC., Dept. 14, Lorain, Ohio.



Pfizer Medical Research Laboratories, Groton, Connecticut. Architects: Shreve, Lamb and Harmon Associates • Structural Engineers: Garfinkel and Marenberg • General Contractor: W. J. Barney Corporation—all of New York City • Structural Steel Contractor: Elizabeth Iron Works, Elizabeth, N.J.



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Connectors** are approved
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The Word From Washington



EDGAR A. POE, Consulting Engineer Correspondent

In Brief

¶ The Small Business Administration has become big business in the course of aiding small businesses. Since its creation in 1953, the SBA has handled more than \$1 billion in loans. The more than 21 thousand loans made by the agency up to September of this year averaged about \$47 thousand apiece.

¶ The Associated General Contractors of America, through its governing and advisory board, predicts the total volume of new construction in 1960 will be close to the all-time high of \$56.1 billion, set in 1959. The board added that the outlook for the construction industry during the next several months will be about normal for this time of the year.

The Superhighways

In 1960, many thousands of American motorists in all parts of the country rode, for the first time, on links of the divided, multilaned, stoplight-free, interstate highway system. Talks with motorists, highway workers, state highway officials, and engineers gave concrete proof that the motorists are ready and willing to pay for completion of the system.

Chances are that the 41,000-mile interstate system will be accelerated during the next two years, despite the repeated rumors of mishandling and corruption preva-

lent in sections of some states. This can be expected, because of the heavy amount of money already invested. However, the "Watchdog" committee, headed by Representative John Blatnik of Minnesota, should have a healthy effect on state highway departments which are responsible for actual construction. A 3316-mile motor trip into eight southern states indicates that fine highways can be built without scandal and apparently at reasonable costs.

It is true that some officials express concern over the prospective upkeep costs facing the states. Nevertheless, they are immediately concerned with getting more and more interstate mileage complete because it is what the people want.

Recruiting Program

A study of the personnel recruiting costs of 102 private industrial firms supplying hardware to the Defense Department has been completed by the Department at the suggestion of the House Manpower Utilization Subcommittee. In this study, 76 of the companies had more than 50 percent of their business with the government. Their recruiting costs for each new engineer or scientist hired amounted to \$1022, compared to \$751 by the 26 other firms whose business is predominately commercial.

The Manpower Utilization Subcommittee has been keenly inter-

ested in what it describes as excessive use of tax monies by contractors in the hiring of engineers and scientists for defense projects. Chairman J. C. Davis, of Georgia, declared that the Subcommittee recognizes abnormally high recruiting costs as a factor in the excessive turnover of personnel. He maintained that excessive personnel turnover detracts significantly from the effective utilization of engineering and scientific talent in our defense effort.

Davis said these high recruiting costs would appear to warrant "even more attention in negotiating contract costs and in specific auditing by the Military Departments involved."

City Planning

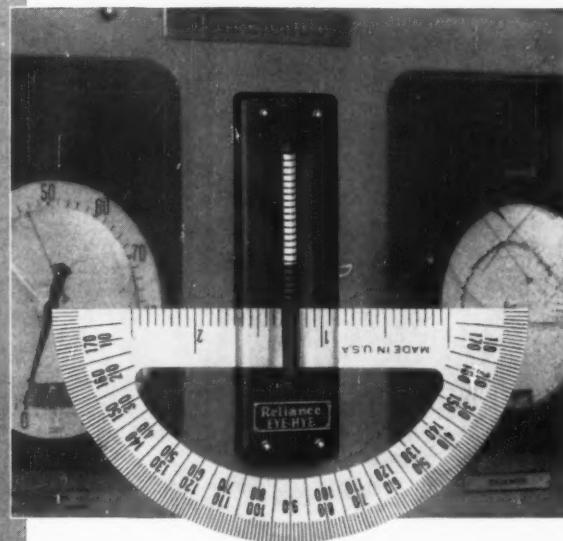
The success of downtown revitalization programs is dependent upon the active support of top community leaders, according to Paul Oppermann, past president of the American Institute of Planners. The National Association of Real Estate Boards published Oppermann's views on "Trends in the Central City - People, Parking, and Planning," in its fall quarterly professional publication, *The Journal of Property Management*.

"Private leadership and private money build the community," said the urban planner. "Public authorities - government officials and planners - provide the framework. If a city is to have an effective

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EYE-HYES are now serving well satisfied users throughout the world, on land and sea. Models for wall or panel mounting; pressures to 3000 psi. Write for EYE-HYE catalog material.

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program, it must develop an organization to create a real partnership between local government and the business community."

Population Explosion

There is growing concern in Washington over blighted central areas, overcrowded suburbs, and ever-increasing taxes, plus vanishing supplies of fresh water in some communities.

The cold, hard facts are, according to Robert C. Cook, president of the Population Reference Bureau, Inc., that unless the birth rate decreases, the problems are going to increase. The Bureau, a nonprofit, scientific and educational organization located in the nation's capital, recently published a summary of 1959 research on world birth rates. The study shows a current increase of 50 million people a year throughout the world, a growth far too rapid for the world's resources. Cooked warned, "Even in the fabulously fortunate United States, the rapid growth and high mobility of our population is piling up problem after problem."

Water . . . Development

A report on the engineering feasibility and economic justification of development of the water resources in Nebraska's North Loup and Loup River valleys is being studied by the affected states and Federal agencies. The report, prepared under the direction of the Bureau of Reclamation, covers part of a proposed \$44,376,000 nine-state Missouri River development, which was authorized under the 1944 and 1946 Flood Control Acts.

Reclamation Commissioner Floyd E. Dominy said major changes in earlier engineering plans make it desirable that the report be presented to Congress for re-authorization.

Water . . . Supply

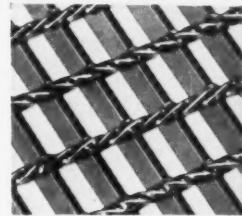
According to authorities at the Office of Saline Water, demand for industrial fresh water by 1980 will



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be five times the 1955 total. Therefore, water problems are going to increase rapidly. By 1980, the predicted demand for fresh water will be 597 billion gallons, exceeding the dependable available natural water supply of 515 billion gallons daily. For this reason, the saline water conversion program must receive increased attention until there is a breakthrough for practical conversion. Our country, of course, has an unlimited supply of saline water to convert to fresh water if it can be done economically.

Water . . . Conversion

The Office of Saline Water has assigned to the Catalytic Construction Company, engineer-architect firm of Philadelphia, the design of a salt water conversion plant at Roswell, New Mexico. Catalytic was chosen from among 65 engineering firms considered by the Interdepartmental Board of Review. The contract calls for a cost plus fixed fee, not to exceed \$96,700.

The New Mexico plant is one of five experimental demonstration stations that will convert salt water into fresh water. Utilizing a forced-circulation vapor-compression process, the Roswell plant will be designed to convert high salinity well water of the Roswell area to fresh water at the rate of 250,000 to 1 million gallons daily.

Building Mexican Roads

A \$25 million loan to aid in developing Mexico's highway network has been made by the World Bank. The loan will finance the foreign exchange cost of building or improving 13 roads with a total length of about 2000 miles.

The roads in Central and Southern Mexico are among the most important in the Mexican government's five-year program to develop its highway system. Rapid growth of the Mexican economy has required substantial expansion of the country's transport system. Today the country has a total of

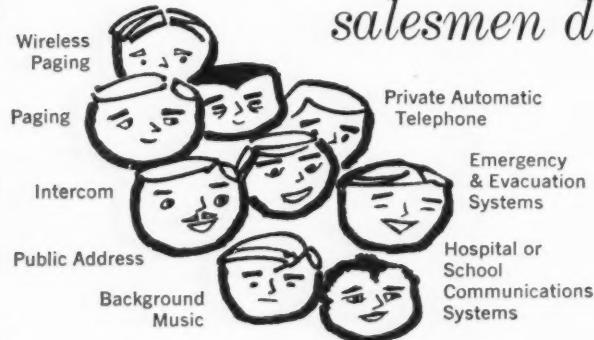
about 28,000 miles of asphalt and gravel highways.

Another Parkinson's Law

The Bureau of Indian Affairs, unlike other Federal government agencies, is seeking to work itself out of business. How? By doing everything possible to make the American Indian self-sufficient. Nevertheless, it will be a long time before the agency folds its tent. For the coming fiscal year, officials of the Bureau say it will continue its long-standing policy of using contractual engineering services whenever the work load of the Bureau's engineering staff has been exceeded or special engineering qualifications are specifically required.

Meantime, the Bureau has no plans to expand its 100-man engineering staff during the next fiscal year. Officials say it is impossible at this time to predict accurately what percentage of its engineering will be farmed out. □

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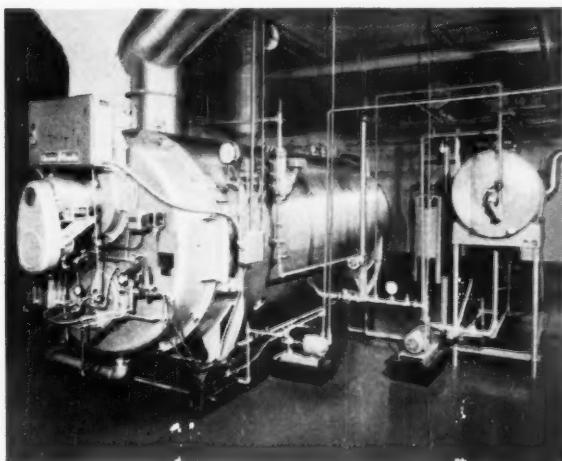


At today's fuel costs

**can you afford to recommend
a boiler designed 20 years ago?**

GETTING MORE HEAT FOR THE FUEL DOLLAR

The W. T. Rawleigh Company, manufacturer of toiletries, medicines and food products for the home and farm, replaced two old firebox boilers in their Memphis, Tennessee, branch with one fully automatic, combination-fired CB boiler. Mr. James Trindle, office manager, reports: "Our records show . . . 36.4% less fuel consumed during winter months that averaged about 12% colder than the previous year. We're getting greater fuel economy than we expected."



Since World War II, less than 20 years ago, fuel prices have soared. And these higher costs put a premium on "little" boiler inefficiencies that might have been ignored when most boilers were designed.

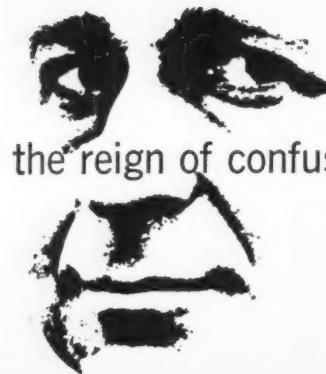
In the face of rising fuel costs, one manufacturer, Cleaver-Brooks, has led the way in up-to-date, "designed in" economy. Modern Cleaver-Brooks packaged boilers provide a combination of fuel-saving design standards that cannot be found in any other boiler — at any price.

It is this combination of features — four-pass design, forced-draft combustion, updraft construction and all the advantages of five square feet of heat-transfer surface per boiler horsepower — that puts fuel costs down where they belong.

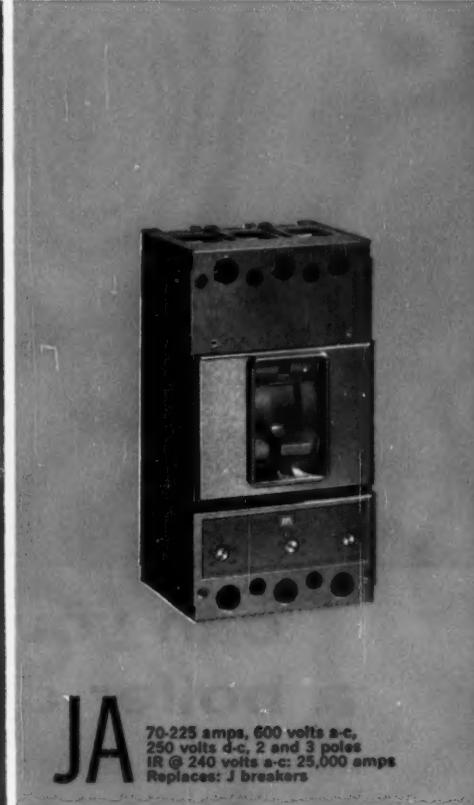
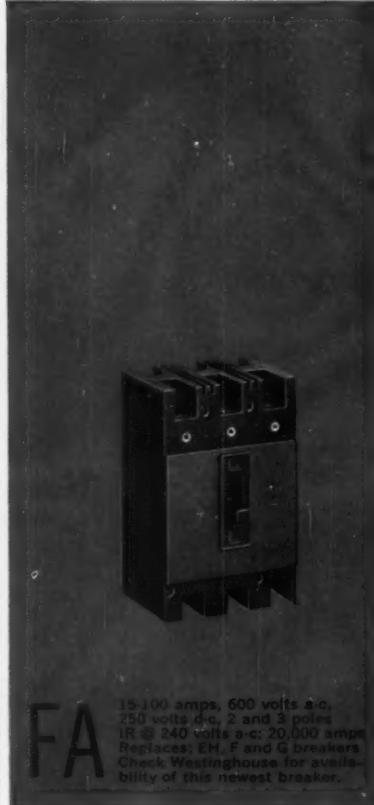
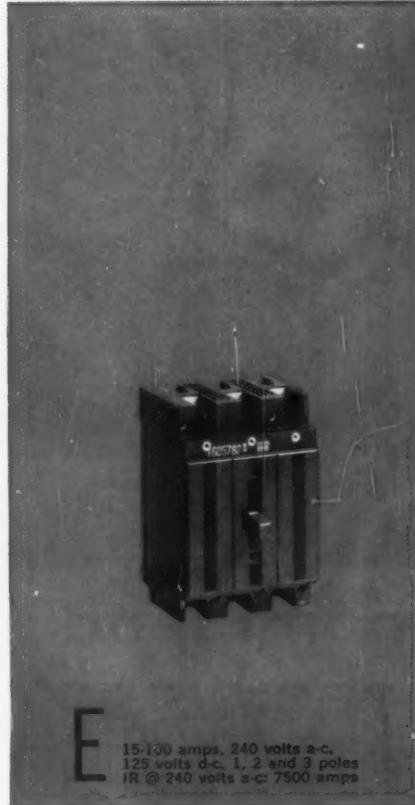
All this is provided by Cleaver-Brooks in the most compact, automatic packaged unit on the market. Sizes through 600 hp . . . oil, gas and combination oil-gas firing . . . larger sizes in Cleaver-Brooks Springfield water-tube boilers. All models completely pre-engineered and tested as a package . . . expertly started by a trained field engineer.

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the reign of confusion is over



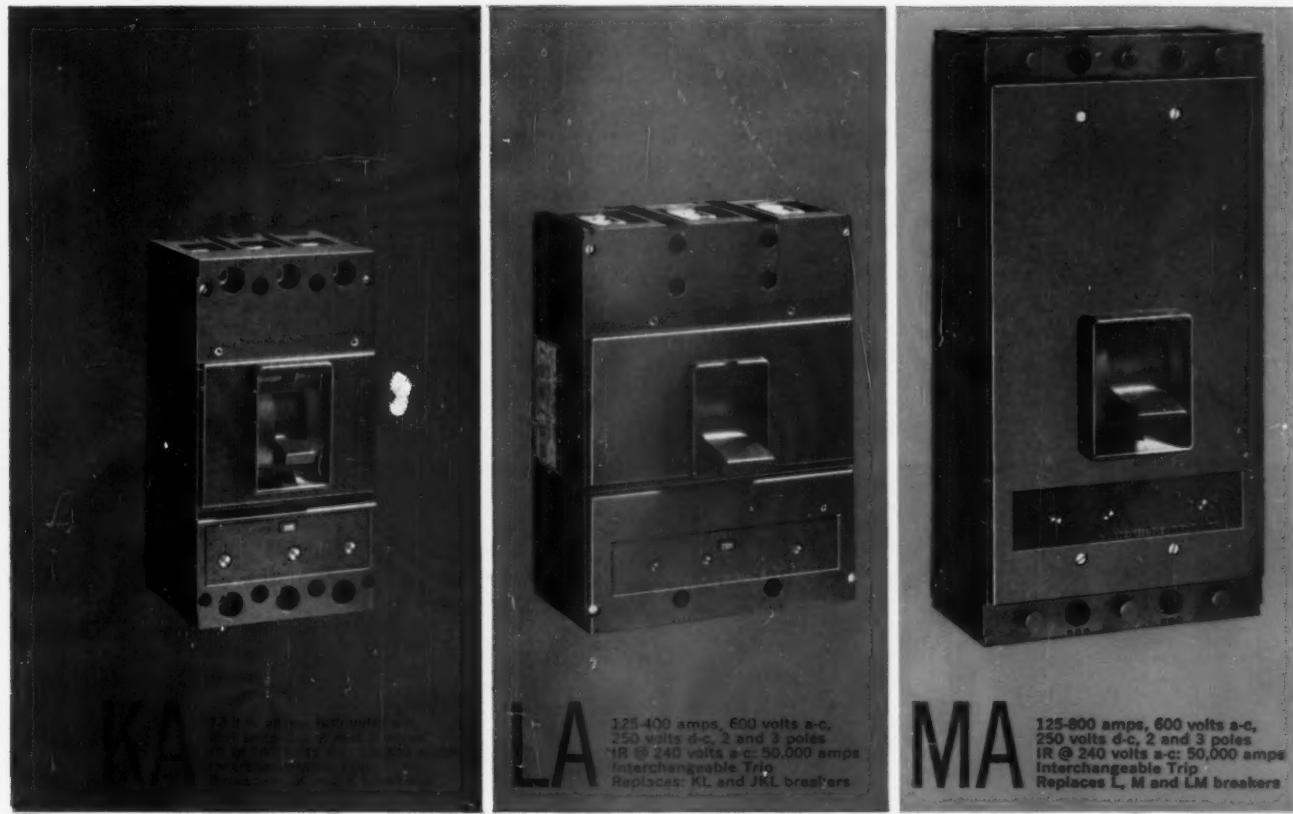
Newly Designed Westinghouse Breakers

The confusing assortment of letters that tagged the breakers of the past should trouble you no more. The reason: clear-cut designations for the new smaller size Westinghouse breaker family.

New designations mean that specifying is simple . . . identifying each breaker is easy.

High interrupting ratings in smaller frame sizes mean you save as much as 50% on space.

The Westinghouse design means that you have extra-long life, unfailing reliability.



J-30320

Are Simple to Specify/Easy to Identify

Any way you look at it, the NEW Westinghouse breakers are the ones you'll want to use.

More information? Contact your nearest Westinghouse representative, Westinghouse distributor, your independent panelboard builder . . . or write Westinghouse Electric Corporation, Standard Control Division, Beaver, Pa.

For a large, plastic laminated wall chart of the new breaker line, write Westinghouse.

All Westinghouse AB breakers meet or exceed NEMA and UL specifications.

You can be sure . . . if it's **Westinghouse**



HERE'S HOW TO MOVE 18 MILLION GALLONS OF WATER EVERY DAY



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DONE



In virtually constant use, Peerless pumps insure dependable water flow to utility's 18,000 customers . . .

The Dominguez Water Corporation has a colorful history that dates back to the early Spanish land grants in California. It was first formed in 1911 and its initial patrons were farmers of land which formed a part of the historically famous Rancho San Pedro.

Today this privately owned public utility serves over 17,000 residences and 1,000 agricultural and industrial customers. Its service area comprises a 35 square mile section in the southern part of Los Angeles County.

Throughout the system, this immaculate-looking facility makes virtually constant use of Peerless pumps. Practically all of the water they distribute is

pumped by Peerless. From tiny 2 hp Fluidyne pumps and large Type A booster units to mammoth deep well turbines, these sturdy pumps keep water moving in a steady flow. Many of the pumps have seen 25 years or more of continuous service. And downtime for repairs is practically non-existent, reports operation personnel.

Years of performance. Lowest possible maintenance attention. Best service. These are typical qualities you can expect and get in a Peerless pump. Get the facts on this fine complete line of pumps now. Write today for a catalog and the name of the Peerless representative in your area.

Putting Ideas to Work

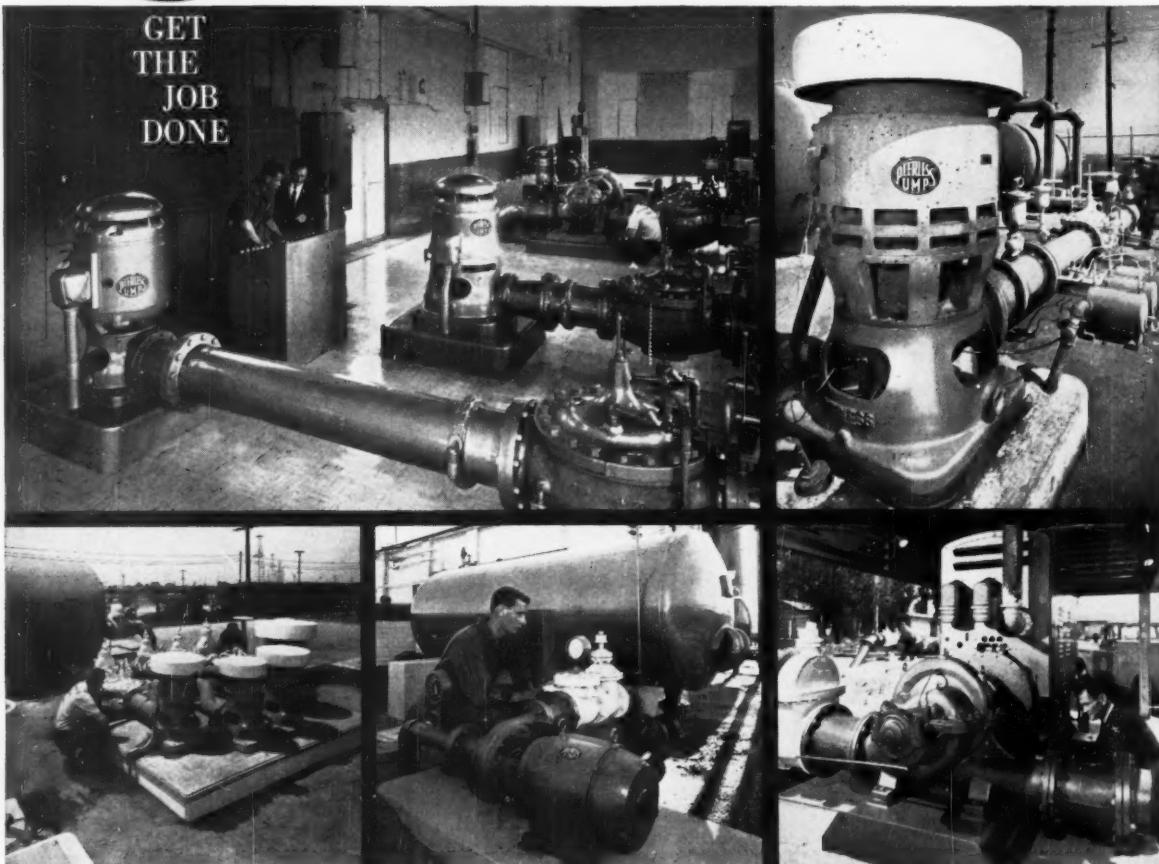


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"Quote... End Quote"

Industry and the Consultant

"To achieve the maximum benefit of association with the consulting engineer, industry must recognize the need for his services during the very preliminary stages of a project.

"This early association affords the engineer the benefit of industry's basic thinking and ideas and, in turn, permits the engineer to fully study and analyze the requirements of a project, review the economics involved, and recommend the ultimate course to be followed.

"After completion of preliminary work, the consulting engineer functions as industry's guide through final execution of the work. During this time, he is available for decisions and any study which may be required on such items as materials handling systems, process design, air handling, waste treatment and disposal, plant layout, and air pollution.

"Industry's awareness of the need for the consulting engineer has reached a new high during the last 15 years. This is exemplified by the number of widely diversified projects on which consulting engineers have been used during this period. This work includes bionucleonics buildings, bioastronautical structures, ion and plasma jet facilities, research and development centers, production facilities,

and now, the entrance into the complex structures and facilities which will be required for our continued challenge of space.

"The wealth of experience gained during this past period is surely the best guarantee the consulting engineer has of industry's need for his services in the future." — Robert P. Dalton, *The Ohio Engineer*, October 1960.

Prestige Through Culture

"The problems encountered by an engineer in the course of his career are by no means all of a technical nature. There are all kinds of problems, and many of them cannot be worked out with a slide rule.

"Labor problems, for instance, cannot be settled on the basis of geometric demonstrations or differential equations. Nor can a construction job be planned without due consideration being given to the human element. Administering a budget has little in common with the principles of hydraulics and mechanics. In short, is it not a fact that in his contacts with his fellow men, an engineer has as great a need for letters as for figures, or as great a need for culture as for technology?

"If, therefore, we are compelled to go a mile in the paths of technology, let us not be afraid to go another mile, either at the same time or afterwards, in the paths of culture.

"Let the position of engineers compare favorably with that of any other group known for its high level of culture. Let engineers, for instance, be among those who read the best books, or even write them, who attend plays and concerts, who are seen in art galleries, and who lend both their ear and their voice to those ideas which, in the long run, determine the course of our civilization.

"The mere language of our profession is too technical for general understanding. In order to be understood by all, one has to speak the language of culture." — Arthur Piche, P. Eng., president of the Corporation of Professional Engineers of Quebec, in the *Bulletin*, Aug.-Sept., 1960.

Political Chains on Science?

"One of the most effective ways for scientists to exchange information and keep abreast of new developments is by way of scientific meetings . . . Foreign scientists sometimes have trouble getting visas to come to this country, and sometimes they find it impossible. This is one problem, but it is not the only one. Some of our scientists — government scientists — find themselves subject to a special ruling that limits their freedom to attend meetings abroad. This special limitation applies to international meetings that will be attended by scientists from countries not recog-

sadly under-employed British atomic industry. Nuclear power stations built to British designs can, if required, produce sizeable outputs of weapon-grade plutonium, and although there is a case to be made for nuclear power in Bombay, it is clear that the Indians want plutonium too. They refuse to give undertakings not to use plutonium for military purposes — undertakings which are normally demanded and given when a nu-

clear power station is exported from one country to another. The head of India's atomic energy industry, Dr. Bhabha, fought long, passionately, and unsuccessfully at the recent meeting of the International Atomic Energy Agency to waive or water down its safeguards against misuse of plutonium.

A plutonium-producing power station of this size (nearly twice that of Calder Hall) would provide an essential base for the pro-

duction of nuclear weapons. Scientists and technicians who have been invited to India during the past six years seem in no doubt that this end is being kept fully in mind. The capacity to manufacture and process nuclear fuels already exists. However understandable India's attitude may be, it poses a question far more taxing than India's ability to pay for the atomic power station. If Britain and the United States stand firm and refuse to supply the installation unless India gives the required safeguards not to use the plutonium for weapons, will France be equally firm? And what of the Soviet Union, whose delegations have told the Indians they would provide fuel without strings — though Moscow has taken no steps to implement any such promise and might have some pointed questions from Pekin if it did. If the British government yields to pressure from the atomic industry here, and gives the Indians what they want, how will it hold other countries, like Japan, to the letter of their agreements?" — *The Economist*, October 15, 1960.

Partnership for Progress

"Our government must improve enormously. If you really want to help government, forget for a while at least the firms, charts and dogmas of efficiency experts, reformers, and civic upholders as to what is national. The agency which can do a job best is the one to do it. But always our task is to find the men and women who can lead, to encourage them, to give them incentives, rewards, status, and respect, and to protect them from gratuitous insult, marginal libel, and dirty, irresponsible guttersnipe attacks. Public servants are not the enemies of private enterprise. They are not rivals. In the partnership of government and individual initiative lies the hope of democracy." — Robert Moses in an address presented to the American Public Works Association. □

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FULLY AUTOMATIC OR SEMI-AUTOMATIC . . . this high efficiency system is manufactured in a wide variety of sizes and models, arranged for firing steam boilers and high temperature hot water generators of all types up to the equivalent of 100,000 lbs. of steam per hour. Available with axial flow blowers or centrifugal blowers fitted with electric motor or steam turbine drive as required.

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Here, as nationally, the electric utilities and the

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nized diplomatically by the United States. Before a government scientist can attend such a meeting as a participant or at government expense, the State Department must be satisfied that no scientist from any nonrecognized country will be present. If any scientist from a non-recognized country plans to attend the meeting, then our government scientists may not go unless they pay their own way. Even if they do pay their own way, they may not deliver a paper at the meeting.

"The State Department justification for the policy is this: if scientists employed by the government should attend meetings along with scientists from, for example, East Germany or Communist China, our policy of nonrecognition would be weakened. The supporting argument is that nonrecognized countries would make the propaganda claim that our scientists are government officials and that consequently their attendance at meetings with representatives from these

countries constitutes *de facto* recognition.

"Whatever the merit of the diplomatic issue, it ought to be weighed against the losses that the ruling entails. It is not the individual government scientist alone who loses; the agency that assigns him to attend the meeting is acting in the national interest, and that also suffers. Do we stand to lose more than we gain by our policy? In one way we clearly do. By the simple expedient of sending a representative to a meeting, a nonrecognized country can block the attendance of our government scientists. We thus allow our participation to be governed by these non-recognized countries rather than by our own national interest.

"Another objection to the argument in support of the policy is that even though the scientists in question do work for our government, they do not represent us diplomatically. Thus the presence of government scientists at a meeting of the kind being discussed cannot reasonably be construed — despite the State Department's apprehensions — as a step toward recognition. The International Council of Scientific Unions in 1958 passed a resolution affirming the right of scientists to participate in international scientific activity 'without regard to race, religion, or political philosophy' and added that such participation 'has no implications with respect to recognition of the government of the country or territory concerned.' In April 1960 the Governing Board of the National Academy of Sciences-National Research Council endorsed that resolution . . ." — An editorial in *Science*, September 30, 1960.

Bombs for India?

"The Indian government has put the West on a hot spot by inviting tenders for a 300 megawatt nuclear power station to be built north of Bombay. This is one of the few possibilities capable of helping the

Vulcathene®
Costs
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Here's the proved, modern way to drain corrosive wastes—at less than half the cost of other systems. Vulcathene has everything you need—pipe, fittings, sinks, traps, in a wide range of sizes—competitively priced for *any* waste system. Save on economical installation and trouble-free, maintenance-free life:

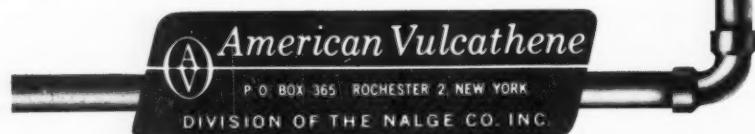
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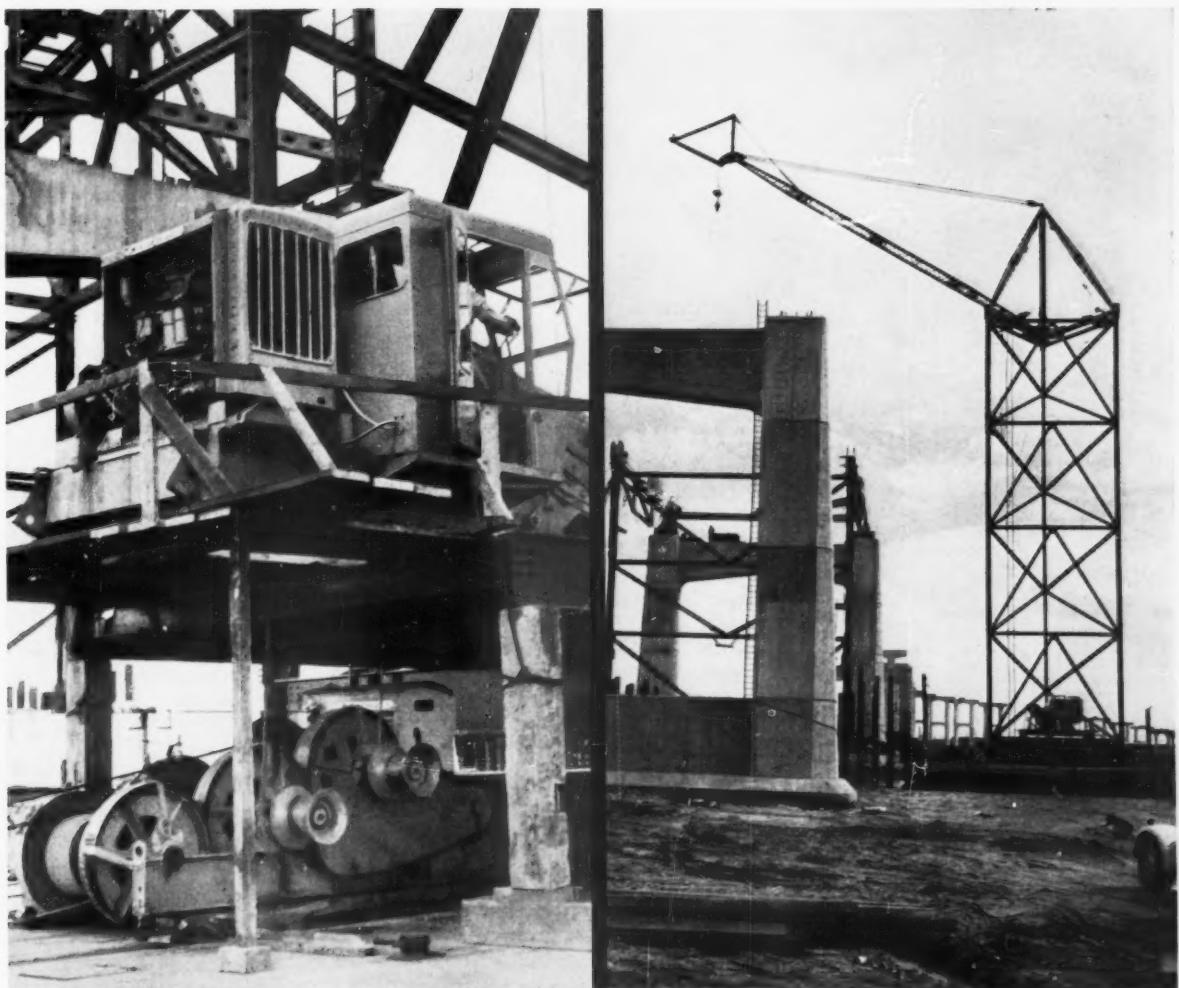
leak-proof joints in *seconds* by the patented Polyfusion® method.

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CLOG-PROOF, SCALE-PROOF! Smooth, non-adhering bore throughout. Find out how you can save *every* way with use-tested, time-tested Vulcathene.

WRITE Dept. 4112 for new catalog.





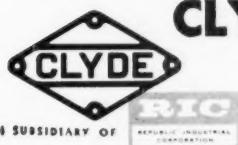
AMERICAN BRIDGE DOUBLE DECKS CLYDE HOISTS ON BARGE MOUNTED TOWER DERRICK

The two Clyde Hoists used by American Bridge Division of U.S. Steel Corp. were years apart in manufacture. In age and appearance they were very different. But in the important measurements of hoist value they are identical twins.

Both Clyde Hoists were carefully engineered, trademarked by integrity of manufacture and performance that equaled or exceeded claim or promise. Both were carefully designed and ruggedly constructed to lower material handling costs with greatest possible safety; to require minimum maintenance and to offer maximum accessibility for servicing.

Clyde has been building good hoists . . . the best hoists . . . for more than seventy-five years.

*Write for Bulletin 34A for specifications
on the complete line of Clyde Hoists*



CLYDE IRON WORKS, Inc.

Established 1899

DULUTH 1, MINNESOTA

HOISTS : DERRICKS : WHIRLEYS : BUILDERS TOWERS
UNLOADERS : CAR PULLERS : ROLLERS



American Bridge Division, United States Steel Corporation has a 165 foot, barge-mounted tower derrick to set steel on the center span of the new high bridge at Duluth-Superior, western terminal of the St. Lawrence Seaway. Two Clyde Hoists were used, one to operate the derrick and one to position the barge.



City of Binghamton sees clear water ahead for a full generation

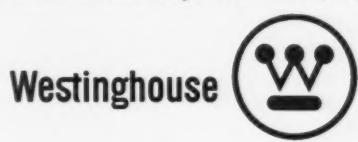
Westinghouse Powers-Up New Filtration Plant to Meet Rising Demands of Next 30 Years

Present population: 85,000—growth reaching at least 105,000 by 1975. This is the future for Binghamton, booming city in upstate New York. With this fact in mind, planning of their new 4,000,000-dollar filtration plant accented expandability for rapidly increasing water demands to 1990.

Westinghouse has provided a power distribution system that will assure this objective. With present pumps and treating equipment, total capacity is 31,000,000 gallons per day. Plant capacity can be expanded 50% during the 30-year period without additional substation, bus or switchgear equipment. Beyond basic flexibility, the electrical equipment will be called upon for absolute, 24-hour reliability for this projected long life span. Westinghouse power components are coordinated to work together, and will fulfill this objective also . . . dependability, with minimum servicing or maintenance.

For look-ahead electrical planning and products to match, call your Westinghouse representative, or write Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pa.

You can be sure . . . if it's Westinghouse.



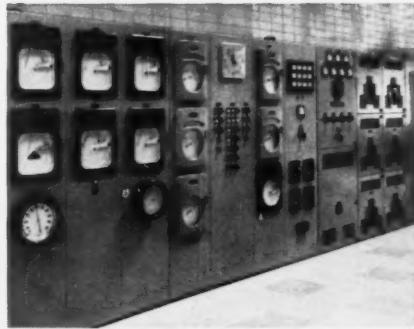
J-94152-2

1. The Susquehanna gives up its water . . . Pipe gallery located under the filter operating floor houses raw water, backwash and waste water lines, control piping and valves.



2

2. Strength, beauty and simple utility . . . Plant exterior is finished in blue glazed brick, yellow porcelain enameled steel panels, anodized aluminum trim.



3

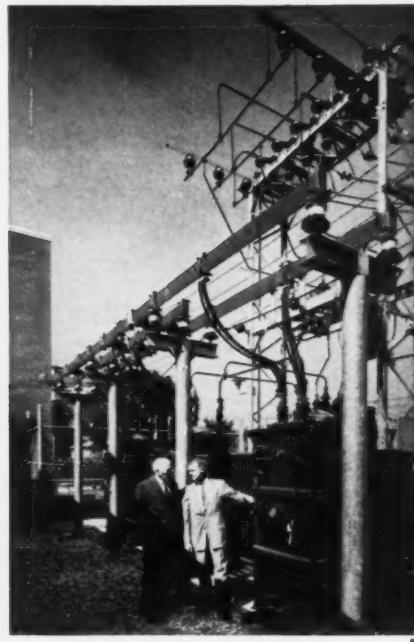
3. Utilized plant control . . . Main distribution center for new plant provides power to motor and auxiliary feeder circuits. Fed by 4000-ampere ventilated low-impedance bus duct, board consists of (right to left) plant service transformer and power panels; 480-volt switchboard with incoming line and motor feeder breakers of reliable DB design; control panels including flow and pressure indicators, gauges and master indicating lights to show status of all plant operating equipment.



4

Entire unit was assembled by Westinghouse and delivered complete and pre-wired for fast, easy installation.

4. Mr. G. E. Rickard, Water Superintendent, checks ammeter reading at incoming switchgear and master control board with Mr. R. C. McNamara, City Engineer, who supervised over-all construction project.



5

5. Dependable power for 30 years . . . G. E. Rickard and R. D. Batley, Westinghouse Sales Engineer, discuss one of three Westinghouse SL transformers in plant outdoor substation. Present bank capacity is 2500 kva—future uprating to 2875 kva is possible through provisions for addition of forced air cooling.

Westinghouse transformers feature exclusive Insuldur® insulation and Hipersil® grain-oriented steel cores to give extended life and higher efficiency. This substation, furnished by Westinghouse, also includes: 15-kv, 600-ampere, 100,000-kva IC oil circuit breakers; Type V disconnect switches; Type S station service transformer; main low-voltage bus as well as the integrated steel structure.



6

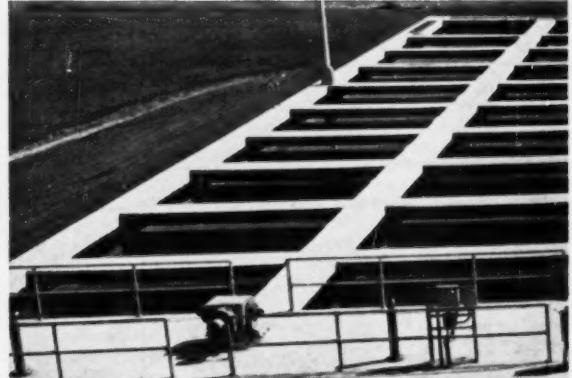
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8



9



J-94152-3

10



Filtration Plant Powers-Up for Next 30 Years

(cont'd)

OWNER: *City of Binghamton*

GENERAL CONTRACTOR: *Smith-Howard and Sprague, Binghamton, N.Y.*

ELECTRICAL CONTRACTOR: *Lord Electric Co., Inc., New York, N.Y.*

CONSULTING ENGINEERS: *Leonard S. Wegman Co., New York, N.Y.*

Alexander Potter Associates, New York, N.Y.

ELECTRICAL DISTRIBUTOR: *Westinghouse Electric Supply Co., Long Island City, N.Y.*

6. Compact, expandable motor control . . . These Westinghouse units, together with the lighting panelboard (door open), centralize control for all auxiliary equipment in the chemical building. Motor starters serve mixers, drives, pumps. Thirty-kva transformer, feeding panelboard, completes assembly. Blank sections, at left, permit future additions.

7. Control for added capacity . . . Starters for high lift pumps include two new Westinghouse reduced voltage autotransformer types to complement several starters moved from original plant. Control accessories were added to modernize these—thus providing an economical conversion to the new control scheme. Westinghouse starters were used to control new 600-hp high lift pump and 125-hp wash water pump.

8. Close cooperation among the consulting engineer, electrical contractor and Westinghouse makes it possible for Binghamton to provide for the future today. Seen at left: A. J. Juris and E. J. Young of Lord Electric Co.; E. Piller, Westinghouse Electric Supply Co.; P. J. Gallagher, Westinghouse; and J. J. Fenley of Lord.

9. Color and light welcome visitors . . . Lobby area is handsome with terrazzo flooring, marble paneling, mosaic tile stair wells. Westinghouse Mainliner fluorescent luminaries blend with building's structural elements. Average illumination intensity is 90 foot-candles.

10. Room for more . . . C. E. Ahern, filter operator, seen at Westinghouse NLAB lighting panelboard which contains normal and emergency breaker sections with spares for future circuits. Flush trim and special brass hinges harmonize with architectural detail of plant.

11. Take water, add chemicals, mix well . . . G. E. Rickard and R. D. Batley inspect the slow mix tanks. Settling tanks in background provide 3½-hour detention. Entire area is illuminated at night to promote safe operation and permit 24-hour observation of flocculation process.

J-94152-4



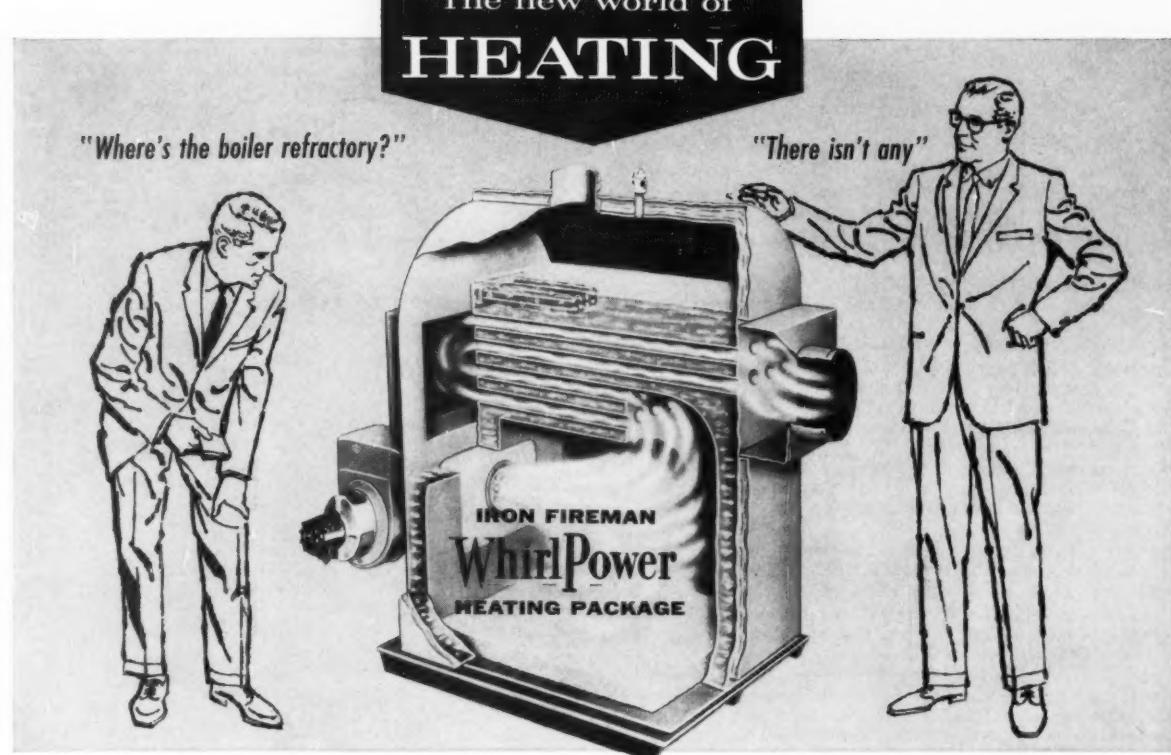
Westinghouse



The new world of
HEATING

"Where's the boiler refractory?"

"There isn't any"



CLEAN FLAME within seconds FROM COLD START

No hot refractory needed to support combustion

The new WhirlPower heating package makes a clean flame in a cold firebox, because it does not depend for its combustion efficiency on the reflected heat of hot refractory. All conditions for complete combustion are created *within the fire-cone itself*. It starts clean and stays clean.

Whether firing oil or gas, the entire air supply is introduced through the firing port, under forced draft, into a sealed combustion chamber. Fuel and air are combined within a firing head of new and unique design. Since firebox pressure remains constant (unaffected by the uncertainties of natural draft) the air volume

can be as accurately metered as the fuel supply.

Exceptional economies in fuel and maintenance

Iron Fireman WhirlPower combustion eliminates many causes of service. Most service calls result from sooted flues, fouled electrodes, dirty combustion controls, or by carbon-clogged nozzles, baked by the reflected heat of hot refractory. The considerable cost of refractory maintenance is also eliminated. With a high resistance to the passage of air through burner and boiler, and no draft-producing

stack, standby losses are reduced to a minimum. This, plus high combustion efficiency, results in substantial fuel savings.

No stack needed; merely a vent

Forced draft and sealed combustion makes a high stack unnecessary. Only an exhaust vent or stub stack is needed, and this can be a third smaller than the usual flue diameter.

For gas, oil or dual-fuel firing—steam and hot water models

Single fuel models are available for either gas or oil. Dual-fuel models switch fuels instantly, either under manual or automatic control.

Mail coupon for full information and specifications



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HEATING AND AIR CONDITIONING
AIRCRAFT COMPONENTS AND EQUIPMENT
MISSILE AND AIRCRAFT GYROSCOPES
ELECTRONIC EQUIPMENT
CONTROL INSTRUMENTS

Iron Fireman Mfg. Co., 3075 West 106th St., Cleveland 11, Ohio
(In Canada, 80 Ward St., Toronto)

Please send full information and specifications on the WhirlPower Heating Package.

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Firm _____

Address _____

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The Legal Aspect

DR. MELVIN NORD
Registered Engineer
Attorney at Law

Third Party Negligence

A RECENT ARTICLE by George M. White, entitled "Architects' and Engineers' Third Party Negligence Liability — The Fall of the House of Privity" (published in the Western Reserve Law Review, Sept. 1959, and in the AIA Journal, Oct., 1960) presents information and views of interest to engineers in private practice.

In his article, Mr. White points out that liability to third persons not parties to a contract was at one time not generally recognized in negligence cases, but that this rule has been greatly whittled away by cases in the last forty-five years. Mr. White goes on to cite several recent cases in which architects have been held liable for negligence in supervising a construction job which entailed injury to third persons who had no contractual relationship to the architect (e.g., a workman on the job, or other persons rightfully on the premises). He concludes that "the paths of professional glory lead but to liability" (or to insurance). His conclusion applies to engineers as well as architects.

Contract Liability

In order to understand the problem of liability to third persons, it is necessary to understand the basic difference between liability in contract and liability in tort.

Liability in contract exists because of an agreement which is legally binding between the parties. The obligation is not owed to the world at large, but only to a certain designated person or persons. Originally, under the common law, no person could maintain an action based on a contract unless he was either a party to the contract, or an assignee of the rights of a party (assuming the contract was of such a nature as to make its assignment possible.)

Third-Party Beneficiaries

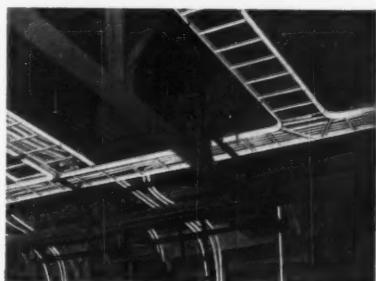
This rule eventually was changed to some extent, under the "third party beneficiary" rule. This rule permits a creditor beneficiary (a person to whom the promisee party owes an obligation which will be partly or entirely discharged by the promisor's performance), or a donee beneficiary (a person to whom the promisee party gives as a gift the promised performance of the promisor) to maintain an action on the contract. In these situations, the promised performance was intended to be given to the third party beneficiary and, although he is technically not an assignee nor a party to the contract, the law now permits him to sue in his own right.

Thus, it is now recognized that a person not technically a party to

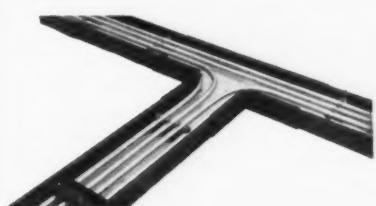
You **SAVE**
15% or more

When You Buy
Chalfant
ALUMINIZED
STEEL
CABLE RACKS

● The first cost is lower . . . The life is longer . . . The material is stronger! Your best buy for fast installation and superior performance is Chalfant Aluminized Steel Cable and Tubing Racks with exclusive boltless crimp-type splice plates.



● 17 year tests prove a life 3 years longer than standard zinc coating on galvanized steel . . . Chalfant Aluminized Steel Cable Racks have a higher heat resistant rating than galvanized steel . . . In salt spray tests, aluminized steel lasted 3 times longer than galvanized steel!



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a contract may have rights under it because the performance of the promise was to be for his direct benefit. In other words, the legal duty in such contract situations extends not only to the person promised, but also to the person who is expected to be the direct beneficiary of the performance. It has been held, further, that the identity of the beneficiary need not necessarily have been established at the time of the making of the contract, so long as it was determined when performance came due.

It should be kept in mind that in these third party beneficiary cases, the beneficiary can maintain the action for failure of the promisor to perform (nonfeasance), or for improper performance (misfeasance). If there is an unexcused breach of the promise, there is liability in either event.

Covenants Running With the Land

Another situation in which a person who is not a party to a contract

nor an assignee can maintain a contract action is where there is a covenant running with the land (real covenant). Such covenants are contractual promises which touch and concern real property, are intended to attach to the real property and run with it, are embodied in a sufficient writing to satisfy the Statute of Frauds as interests in land, and are between persons in privity of estate with respect to the real property to which the covenant is to attach. Privity of estate means that at the time of the execution of the covenant there existed a legal relation between the parties directly relating to the real property in question (e.g., vendor and purchaser of the land, or landlord and tenant). For example, the purchaser may promise or covenant, in the deed by which he takes title to the land, that he will not build any house on the lot which is set back from the street less than a specified distance. This promise is, by hypothesis, made for the benefit of other

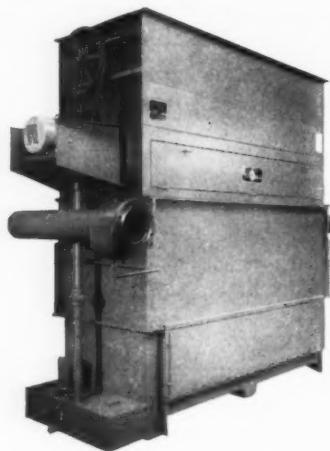
adjacent land retained by the vendor. Now, if the vendor sells the remaining land to another person, the latter (as the new owner) automatically steps into the shoes of the original vendor, even though no mention was ever made of the covenant. The covenant runs to whomever the owner of the land may be, and he can enforce it in his own right, although he is not technically a party nor an assignee to the original contract.

One of the most common situations in which covenants running with the land are found is in the case of warranty deeds. In these, the vendor of the land makes certain express warranties (covenants) in the deed, which are to run with the land, e.g., the covenant of quiet enjoyment (that is, that the purchaser will not be evicted by the vendor or by a person claiming a title superior to that of the vendor). These covenants or warranties need not be expressly assigned when the property is sold, as they automatically run with the land.

How to get drier or cooler AIR or GASES at low cost

NIAGARA AERO AFTER COOLER cools a compressed gas, or air, below the temperature of the surrounding atmosphere, thus preventing the condensation of moisture in your lines. The gas will contain only half of the moisture left in it by conventional methods. Even drier gas can be produced if you require it.

In working with controlled atmospheres of inert gases to prevent undesired reactions, this dryness of the gas at low cost is a great advantage. The cost of the Niagara method is low because it uses evaporative cooling, saving 95% of the cost of cooling water (and its piping and pumping). This direct saving of cost pays for the Niagara cooler in less than two years.



If you use compressed air to operate instruments or pneumatic equipment you will get better results by using the Niagara Aero After Cooler.

Write for Bulletin 130, or ask nearest Niagara Engineer if you have a problem involving the industrial use of air.

NIAGARA BLOWER COMPANY

Dept. CO-12, 405 Lexington Ave., New York 17, N. Y.

Niagara District Engineers in Principal Cities of U. S. and Canada

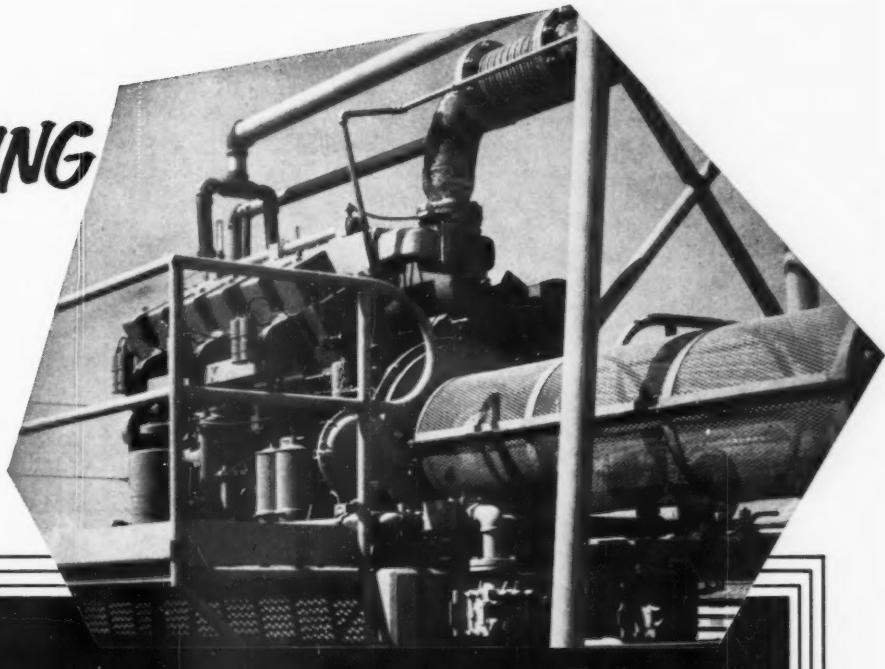
Warranties in the Sale of Goods

In the case of the sale of goods, the questions arise whether any warranties have been made by the seller, and if so, whether they run with the goods in a manner analogous to that of covenants running with the land.

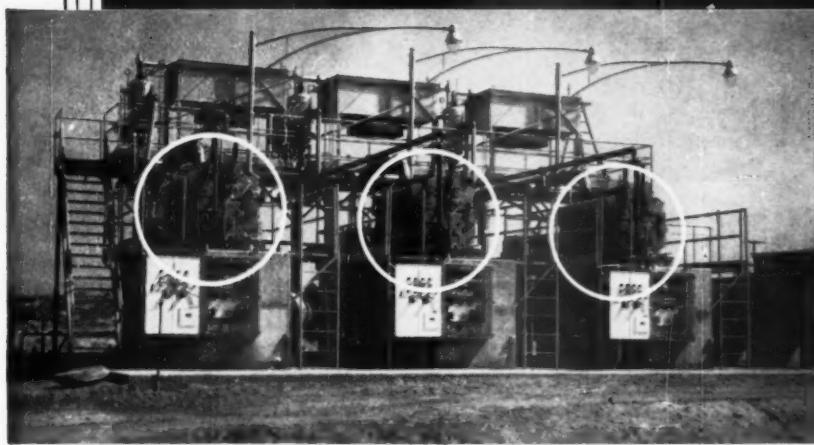
It is possible that there may be express warranties in the sale of goods. For example, there may be a promise that the goods to be delivered will correspond in quality to a sample which was the basis of the bargain. Such a promise clearly gives the purchaser a contract action if it is breached by the seller. Furthermore, the purchaser can expressly assign the warranty to a subsequent purchaser, and the latter will then have a right to maintain an action if the promise has been breached. However, unless there is such an express assignment, the subsequent purchaser has no rights under the warranty; it does not automatically

PROTECTING

outfall
basin
fluid
level



three **CLIMAX** V-122
ENGINES
power outfall booster pumps



In the Orange County treatment plant, ordinarily the treated sewage flows by gravity from the plant through a 3000 ft. long outfall conduit to the ocean. But an increased inflow to the plant, or a high tide, or a combination of both, causes the outfall forebay fluid level to rise. At a pre-determined point Pump Unit No. 1 starts, warms up, then goes on the line. Further increases in fluid level bring Pump Units No. 2 and No. 3 into action, when necessary. The three Climax

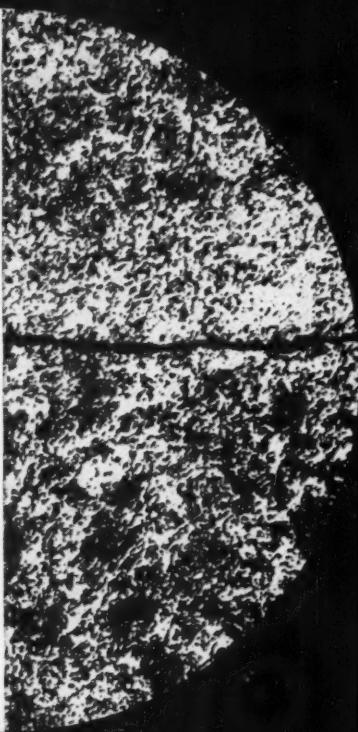
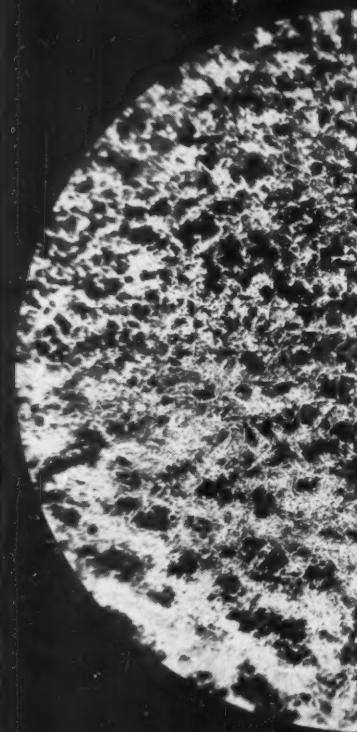
Engine powered Pump Units can handle maximum flow at the highest tide, and then some. With a decrease in outfall forebay level, the operation reverses—the units dropping off as need diminishes. For sewage treatment plants—seven rugged Climax Engine models . . . 12, 8, and 6 cylinders, burning sludge gas, or capable of operation on natural gas, butane, gasoline, or any combination . . . ranging from 100 hp to over 600 hp. Write for engine bulletins.

At Orange County, California, Sanitation District, Plant 2, three Johnson vertical flow centrifugal type outfall booster pumps are powered by three V-122 Climax 3232 cu. in. engines: 12-cyl., 60° V-type, 7" bore x 7" stroke. Engines are equipped with ebullient cooling, full automatic starting and speed regulation; burn sludge gas, with natural gas for standby, and drive through Western BSV-144 right angle gears, ratio 2.1304:1.

CLIMAX ENGINE MANUFACTURING CO. • DIVISION OF WAUKESHA MOTOR COMPANY
FACTORY—CLINTON, IOWA

CL-118

why TRU-WELD is a stronger, better grating



photomicrograph of grating welds

This enlargement of the weld area in TRU-WELD grating shows how solidly the metals have joined. Cross bar and bearing bar have fused into a strong, moisture- and vibration-proof weld.

Enlargement of an incomplete weld area. Note the line of separation between bearing bar and cross bar. Heavy traffic and vibration can easily separate such a weld.

Tru-Weld grating is stronger because it is *made* that way. Its added strength comes from a manufacturing process that completely fuses the metal at cross bar-bearing bar joints and holds the bars to exact spacing. The result is grating that stands up under excessive vibration, heavy traffic or in areas where corrosive fumes and moisture are a problem. And Dravo Tru-Weld grating costs no more.

Complete estimating, layout and fabricating services are available. Immediate delivery from stocks maintained at nearby Joseph T. Ryerson Service Centers will help you meet exacting construction schedules.

For more information on this new, stronger grating, call the Dravo representative in your area, or write DRAVO CORPORATION, PITTSBURGH 25, PA.

DRAVO
CORPORATION

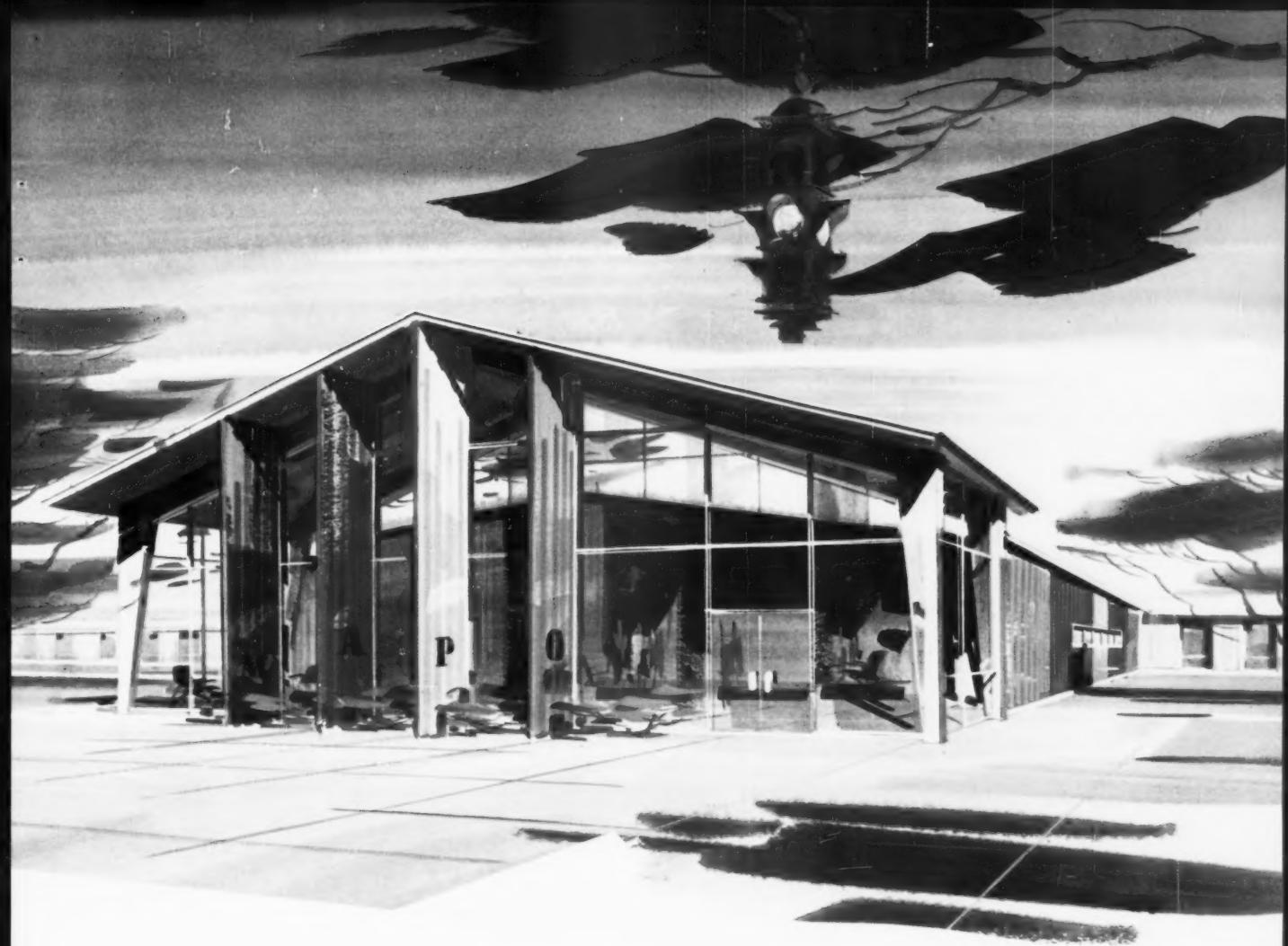
ly run to him. Even if the first purchaser personally made a similar warranty to the second purchaser, the latter would have no contract action against the original seller. He would have an action against the first purchaser (who sold to him), and the first purchaser would have a similar action against the original seller, but there would be no direct action by the second purchaser against the original seller.

The reason is that the second purchaser was not a party to a contract with the original seller, nor an assignee of the rights of such a party. (By hypothesis, no intention to assign is shown, and there may also be a Statute of Frauds problem.) Nor was he a third-party beneficiary of the first contract, since at the time of the making of the first contract there was no intention to have the right run to the benefit of any other party, either as a creditor or a donee beneficiary.

In the sale of real property, warranties are never implied; they must be expressed in the deed in order to be binding. In the sale of personal property, however, many warranties may be implied by the law where the facts suggest that the parties so intended or would have so intended if they had considered the matter. There is no reason to assume that the parties intended these implied warranties to run with the goods to subsequent owners, since the parties did not even think of providing expressly for them on their own account. Thus, the general rule is that neither express nor implied warranties automatically run with the goods to subsequent owners, and there is thus no contractual liability where there is no privity of contract.

Thus, in contract law, there is no liability to third persons, — if we define third persons as persons who are not in privity with the defendant.

(Next month: the relation between contract and tort liability.)



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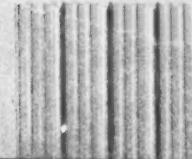
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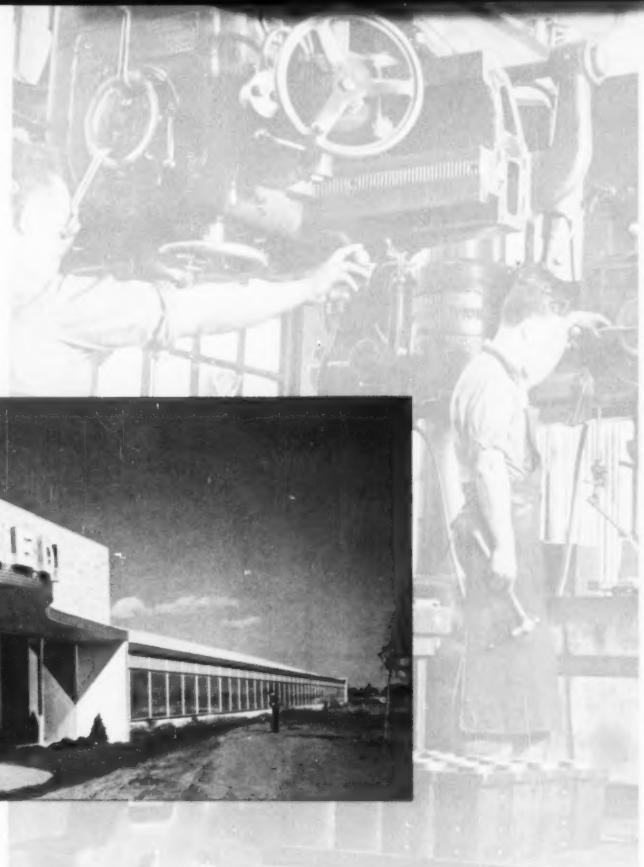


Coast to Coast

...industry finds advantages in
BUTLER BUILDINGS



Flick-Reedy Manufacturing Corporation, Bensenville, Illinois, winner of Factory Magazine's 1960 "Plant of the Year" award. ARCHITECT: Zay Smith & Associates, LaGrange, Ill., DESIGNER: Norman Steenhof.



Southwestern Plastics, Houston, Texas

District office for Westinghouse Electric Supply Company, Worcester, Mass., one of six Butler buildings recently completed for The Westinghouse Electric Supply Company throughout the country.



Manufacturing . . . warehousing . . . distribution, industry finds that the Butler Building System suits all three functions.

. . . like floor space. Clear-spans bridge areas up to 120 feet.

. . . like overhead space. Rigid frame design provides space for lights, craneways, other fixtures. Raw and finished inventories stack to maximum pallet heights.

. . . like expandability. Adding to a Butler is easy, fast, economical . . . with practically full salvage of original materials.

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"See Sweet's Industrial or Architectural File—Section 8-B"



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The High Spots



Computer Chart

A new chart of the characteristics of electronic digital computers is available on request from Adams Associates, 142 The Great Road, Bedford, Massachusetts. The chart, covering 43 U. S. built computers, appeared in edited form in the Sept. 10 issue of *Business Week*.

Reinforced Concrete Handbooks

The Wire Reinforcement Institute has announced publication of a new *WRI Airport Concrete Pavement Handbook*, giving descriptive data and design criteria for the use of reinforced concrete in airport runways. The hardbound, 96-page book is illustrated with pictures, tables, and design sketches.

WRI also has released its new *Building Design Handbook*, covering the general field of reinforced concrete construction. The book is divided into two sections, one dealing with the use of steel wire fabric and the other with the increasing application of heavy welded wire reinforcing.

Both books are available without charge from the Wire Reinforcement Institute, 1049 National Press Building, Washington 4, D. C.

Advances in Solar Power

Doctor Henry Tabor, of the Israel National Physical Laboratory, has developed a new "solar pond" for power generation in countries

where there is still a low national consumption of electricity. The solar pond, which stores energy at the bottom of a pool by heat inversion, is reported to cost about \$250 per kilowatt installed.

Rebuilding Agadir

The International Cooperation Administration has engaged the firm of Harland Bartholomew and Associates, St. Louis, to prepare a master plan for rebuilding the city of Agadir, Morocco, which was recently destroyed by earthquakes. The plan, being drawn up at the request of the government of Morocco, will determine how and where almost an entire new city will be built.

Pipelines for Solid Transport

Charles C. Whittlesey, president of the New York engineer-constructor firm of Ford, Bacon & Davis, Inc., predicts pipelines of the future that will carry several products at once, and others that will carry solid material, such as grain and coal, in addition to the fluid materials now handled. Addressing the members of the Southern Research Institute, Whittlesey also pointed out the possibility of using long pipelines as process plants. Several component material could be introduced successively along the line, and by the time they reached their designation, they would be thoroughly mixed.

Whittlesey raised the ugly, if practical, head of planned obsolescence in construction. He suggested that it would be more economical to use construction equipment which would wear out after about 50,000 hours, and could then be discarded. The net cost would not be so great as on equipment lasting 300,000 hours, which has a higher first cost and would have to be maintained.

Prestressed Concrete Convention

Arthur R. Anderson, a partner in Anderson, Birkeland, and Anderson, of Tacoma, Washington, called on structural designers to make more use of prestressed concrete. Addressing a meeting of the Sixth Annual Convention of the Prestressed Concrete Institute in New York, Anderson also evaluated various design concepts for prestressed concrete bridges. The convention was unusual because of the degree of international agreement reached by the participants, who came from both sides of the iron curtain.

IRF Fellowships

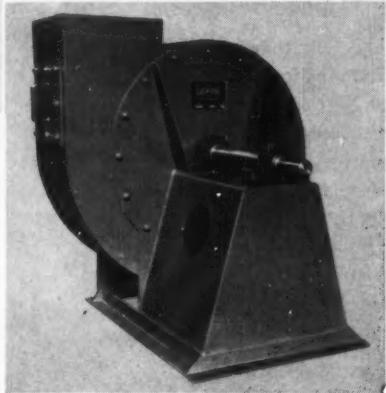
Forty-eight engineering students from 38 countries are enrolled for post-graduate training under the 1960-61 fellowship program of the International Road Federation, the largest enrollment since the IRF program was started in 1949. Most of the students are studying at



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four American universities: Ohio State, Yale, Northwestern, and Purdue. The others are attending Birmingham and Durham Universities in Great Britain. To date, the IRF program has aided 264 engineers from 71 countries.

Architects and Contractors

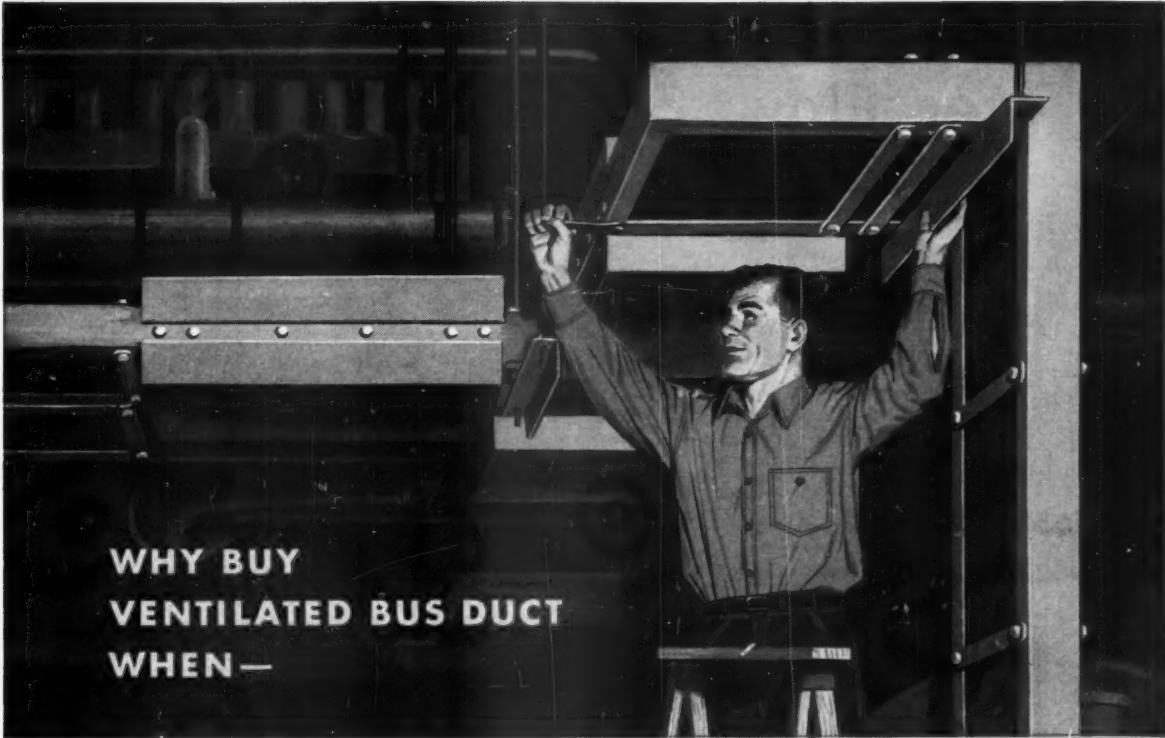
The American Institute of Architects and the Associated General Contractors of America have issued a joint statement affirming their views regarding the respective roles of architects and contractors in the construction industry. A joint meeting of the AIA and AGC was held in Las Vegas in connection with the fall meeting of AIA's board of directors.

At this meeting AIA reorganized many of its administrative procedures, hoping to enable the Institute to act more effectively on behalf of architecture as a profession. One of the internal changes was the establishment of a new committee known as the AIA-AGC Joint Cooperative Committee. Members decided the new name more truly reflected the nature and scope of the activities of the joint committee.

AIA also issued a statement of clarification, following an article, in the June issue of *The AIA Journal*, which described architects as the "master builders." Both groups meeting in Las Vegas agreed this was subject to misinterpretation, and the AIA statement says the group will neither recommend that architects replace contractors nor endorse separate contracts in preference to the general contract form now in use.

Toward a Bigger New York

The Aluminum Company of America, in conjunction with Webb & Knapp, Inc., has announced plans to build a \$40 million development of apartments and offices adjacent to the present site of the UN along the East River. The 103,000 sq ft tract, north of the Secretariat building, is bounded by 48th and



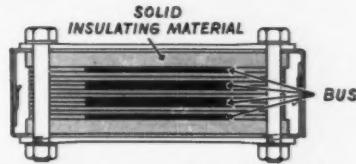
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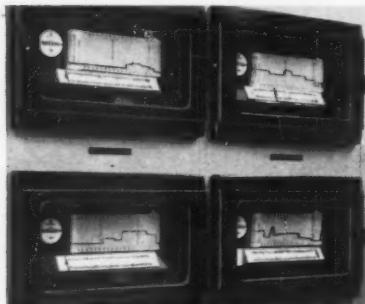
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PERMANENT RECORDS of flow provided by adequate instrumentation in any metering installation enable water works engineers to conduct a continuous study of daily production, overall consumption, variations in demand and seasonal fluctuation. Accurately recorded information makes it possible to control flows and anticipate trends for a higher degree of overall operating efficiency.

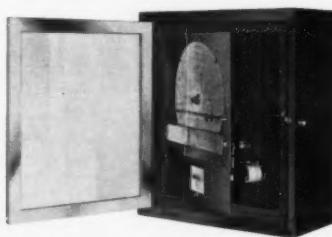
For modern, complete, centralized control, every meter in a distribution system and in process functions may be monitored at one location reducing the need for on-the-spot checks of remote installations.



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49th streets. Although no exact plans have been made yet, the developers say the principal structures will be luxury cooperative apartments and an office building, all of aluminum and glass. Project architect, Harrison & Abramovitz, of New York, will design the entire block to complement the architecture of the UN enclave.

Air Conditioning Pays for Itself

A survey made by Engineers, Inc., of Newark, New Jersey, shows that lowered productivity and lost time during hot weather in the average industrial plant amount to more than the cost of air conditioning that plant. The survey showed that \$70 to \$220 is lost per man per year in plants which are not air conditioned. A similar survey by the General Services Administration showed that a seven-minute saving per employee per day, totaling an average of \$60 per year, is more than enough to pay for the air conditioning system.

The survey by Engineers, Inc., showed that absenteeism and decreased production were the major problems in hot weather. It also showed, in the same period, a greater incidence of work breaks, earlier stopping and later starting times for machines, and an increased number of accidents. The study was made on a cross section of light manufacturing and assembly plants in the metropolitan New York area.

Nordic Calculators

Electrical engineering students at the Technical University of Denmark are taught the operation and use of the digital computer from the first year of study, with the idea of teaching young engineers not only how, but also when to use the computer. The techniques used in the Danish school for teaching the use of the digital computer were described by Ole Franksen in a paper delivered at the fall meeting of the American Institute of Electrical Engineers, in



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Fig. 19084—Steel Pressure Seal Non-Return Globe Valve for 900 pounds W.P. Spur Gear operated. Can also be furnished with bevel gears if required.



Fig. 11365—Steel Pressure Seal Horizontal Lift Check Valve for 1500 pounds W.P.
Powell streamline design assures maximum flow through with minimum pressure drop and turbulence.



Fig. 11313—Steel Pressure Seal Gate Valve, with By-pass, for 1500 pounds W.P. By-pass valve is Powell Integral Bonnet Angle Valve, Fig. 1333A, for 1500 pounds pressure.

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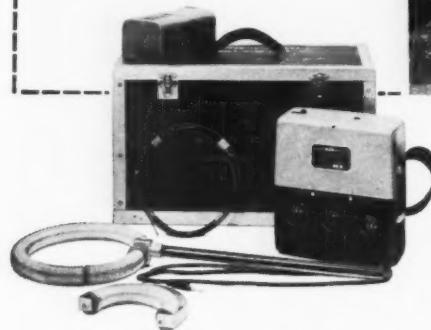
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Chicago. Franksen, a student member of AIEE, is studying at Rensselaer Polytechnic Institute on a NATO fellowship. He said that until 1959 students in Denmark were trained in the use of the Danish computer DASK. Since then, they have switched to the new international computer ALGOL.

Membership and Dues

A study by the Office of Science Information Service of the National Science Foundation shows that engineers join more professional societies, and pay more in dues, than any other group of scientists. Published in the October 7 issue of *Science*, the results of the survey of professional societies lists 35 engineering groups, with an average membership of nearly 15,000, and median annual dues of \$15.

The Engineer as a Writer

John Kent, director of the American Industrial Writing Institute, claimed recently, in an address to a group of engineers in California, that the trouble scientists and engineers have with clear writing stems from their training, which tends to make them explicit and precise in their written statements, so that they qualify each statement or idea with limiting phrases, and wind up with long, involved sentences which are hard to understand and may require re-reading by the average reader.

Kent says shorter sentences mean higher readability. Short sentences permit spacing ideas. They clarify the relationships between words. Technical words add to the trouble. They cannot be shortened. Shorter sentences compensate for this limitation. The AIWI helps people write better. It is in Pasadena, California. The address is P. O. Box 5453.

An Engineer on Schools

The recently published 1960-61 edition of *American School and University* contains an article by Hartford, Connecticut, consulting

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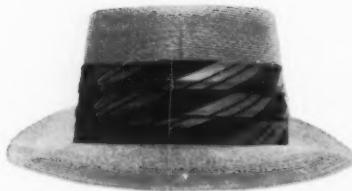


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engineer Fred S. Dubin, titled, "Heating, Ventilation, and Cooling for School and College Buildings — Developments and Trends." In his article, Dubin stresses the need for coordination between the engineer and the architect for integrated design. On the technical side, he evaluates the changing factors involved in school design; new educational concepts; contemporary architectural style; economic factors, and development of building codes.

Standardization Seminar

Dr. John Gaillard will hold a five-day seminar on industrial standardization January 23 through 27 in the Engineering Societies Building, New York City. The seminar is intended to help in standardizing work in individual companies, in training standards engineers, and in writing specifications. Details are available from Dr. John Gaillard, 135 Old Palisade Road, Fort Lee, New Jersey.

Acres Back to Canada

Controlling interest in H. G. Acres & Co., Ltd., one of Canada's largest consulting firms, was recently purchased by a group of the company's senior members. The Fluor Corporation, of Los Angeles, has owned 60 percent of the Niagara Falls, Ontario, firm since 1953, when Acres sold control in order to meet impending retirements. No management changes accompanied either transaction.

Engineers Anonymous?

This year's Fall Conference of the Building Research Institute was held in Washington, D. C., November 15-17. BRI said that the science of building will move another step forward through the information gathered at this conference. It may be a shaky step. There were talks scheduled by architects, builders, salesmen, labor leaders, management officials, and government representatives — but not a single consulting engineer. □

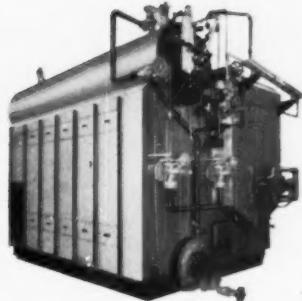
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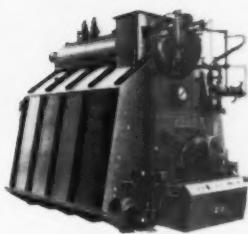
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This booklet outlines some facts which are basic to packaged water-tube boiler design. In addition it provides a check list to assist in specification writing and bid evaluation, and shows why so many consulting engineers specify Superior Packaged Water-Tube Boilers.

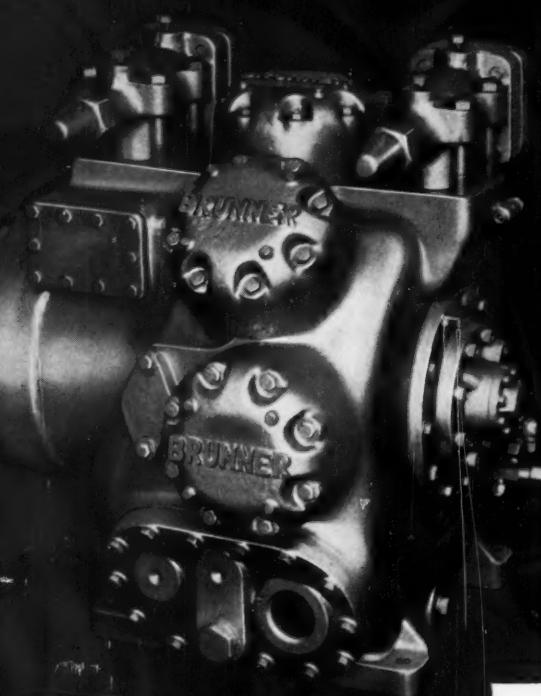
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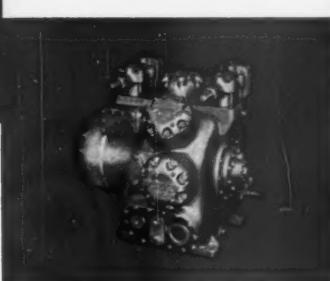
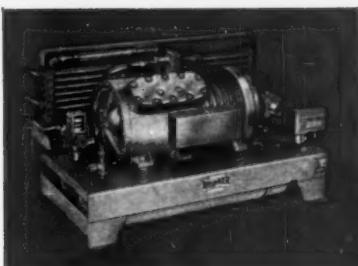
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Complete specification data sheets on request Section A pages 9-10 9a-10c

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Our Authors



Robert W. Richards received his second degree from Princeton 16 years ago, and since then has specialized in writing and editing reports and specifications. He taught military students at Princeton and Swarthmore during the war; after that he went to work for the Budd Co., of Philadelphia. In 1950 he joined the consulting firm of

Howard, Needles, Tammen and Bergendoff as a highway engineer. Later, Mr. Roberts became a specifications and report writer, and in 1956 was promoted to his present post as New York office manager and executive assistant to the four partners. He is a Fellow of the American Society of Civil Engineers, a member of the Franklin Institute, and a registered professional engineer in New York and Pennsylvania. His suggestions for reducing engineers' error (page 130) are based on his years of experience in spotting and eliminating possible sources of error.



Robert B. Newman has been working in the field of acoustics for over 20 years. He received Bachelor's and Master's degrees in Physics from the University of Texas; later he earned a Master of Architecture degree from the Massachusetts Institute of Technology. Mr. Newman is vice-president of Bolt Beranek and Newman, Incorporated, of Cambridge, Massachusetts, and is in charge of the firm's work in architectural acoustics. In his spare time, he is also an Associate Professor of Architecture at MIT and a visiting lecturer in acoustics at Harvard and Yale.

Mr. Newman is a Fellow of the Acoustical Society of America and a former chairman of its Committee on Architectural Acoustics. He has written several articles for professional and technical publications; his views on the importance of acoustics planning in design are on page 94.

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The Significance of SOUND

ROBERT B. NEWMAN
Bolt, Beranek & Newman

CE exclusive

EVERY BUILDING has acoustics problems, and the engineer or architect who does not recognize and accept this fact is neglecting his duty to his clients. Apartments, hotels, office buildings, hospitals, and schools need acoustics planning just as careful as that traditionally given to churches and concert halls. Consider the situation in which a secretary complains that, while she likes the new building very much, when she takes dictation from her boss, she frequently gets confused by dictation being given in the next office. Or look at the new school in which the French class is forbidden to sing because it is disturbing to the Latin class in the next room. Situations of this sort are inexcusable, yet they occur — because designers ignore the simple principles of sound control.

Building acoustics is concerned with the provision of a satisfactory acoustic environment for whatever the occupant of the building may wish to do, and the provision of good hearing conditions where this is important. These design criteria are perhaps the biggest problem facing the consultant in acoustics. What is a satisfactory environment? What are good hearing conditions? The answers

to these questions vary greatly with the function of the building and the individual preference of the occupant. In his church, a client will want isolation from outside noises; in an office building or apartment house the demand will be for privacy between occupied spaces. The client may want confidential privacy, or only conversational privacy — freedom from distraction, or from annoyance.

No matter what the requirement, the designer must give careful consideration to the selection of partitioning systems, the design of ventilating systems, and the layout of all connections between elements forming divisions of the building. Good acoustics in a building concerns every aspect of planning, from site selection, to determination of materials, finishes, shapes, and special relationships.

If the occupied space is completely quiet, the demands on the building structure separating this space from its neighbors are tremendous. If, on the other hand, the occupied space is relatively noisy, lightweight partitions may give adequate isolation.

Background Noise Level

One basic concept, well understood today, is that the degree of privacy or isolation between occupied



spaces depends upon both the sound isolating value of the separating construction and the background noise in the occupied space. We must consider both of these factors in the design of modern buildings. For example, adjacent classrooms (Fig. 1) can vary appreciably in acoustical privacy. Where ambient background noise level is low, an instructor's voice can penetrate the partition with enough volume to be distracting. Where the ambient background noise level is higher, the voice still can be heard

in the original room, but in the adjoining one it is lost among other unrelated, indistinct sounds.

We see, then, that it is impossible to establish criteria for partition, floor, and ceiling sound isolation until we know what the background sound levels will be. People often are surprised to find that a partition which was perfectly satisfactory in a city office building is quite inadequate in a quiet building in the country — same partition — less background noise.

The most effective background noise seems to be an unobtrusive continuous sound that conveys no information — a quiet wind in the trees, a distant waterfall. But, in modern buildings, background noise usually comes from the ventilating system, from traffic, and from all the other mechanical contrivances of modern civilization.

Some Basic Principles

Sound is a to-and-fro motion of molecules in the air. These molecules push and pull on each other, giving a progressive wave that travels at about 1100 feet a second. When a sound wave encounters a barrier such as a partition, the molecules in the air push intermittently on the partition, and the partition moves back and forth a little. This motion gives rise to a new sound wave on the other side of the partition, and we have transmitted sound. The heavier the partition, the less it moves under the impact of these alternating motions in the air, and the less sound is transmitted.

On the other hand, if a sound wave encounters a porous, fuzzy material, the wave will penetrate

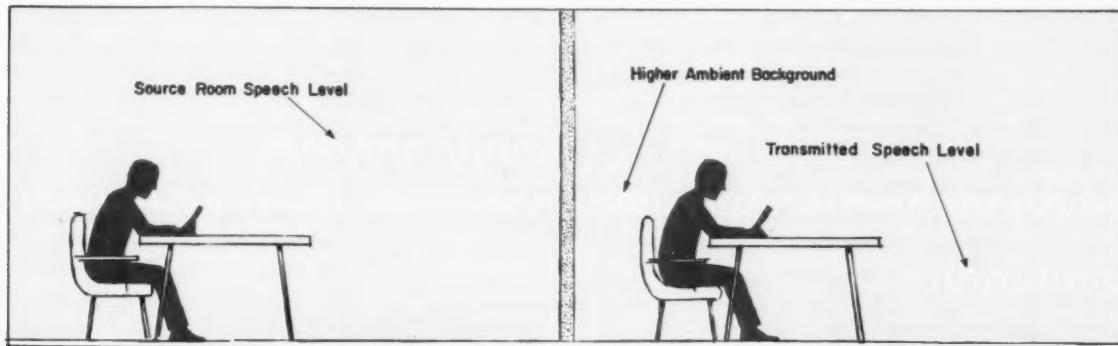


Fig. 1. The teacher's voice is heard in the room at left, but is masked by ambient noise in the next room.

into the porous structure with a scraping back and forth of the fibers in the material and a consequent transfer of energy into heat. This mechanism we call sound absorption. Draperies, carpets, clothing, hair, and many such porous materials, including the commercial acoustic tiles, absorb from 30 to 80 percent of the sound energy that strikes them. A sound absorbing material, being porous, almost always transmits a great deal of sound — it is more or less transparent.

It is extremely important to understand the basic difference between the mechanisms of sound absorption and sound isolation. One demands porous, lightweight, fluffy materials. The other demands heavy, solid, impervious material. It is very difficult for one material to perform both functions, and there is still a great deal of confusion about the use of sound absorbing materials in sound isolation. Sound absorbing materials on ceilings and walls are useful in controlling the spread of sound, reducing the noise level, and providing a pleasant "feel" within the space. Most sound absorbing materials, however, add almost nothing to the sound isolating properties of separating structures. The sound isolating properties are determined largely by mass and stiffness.

Partitions

The ideal partition is a mass controlled system with very little stiffness. As a partition becomes stiffer

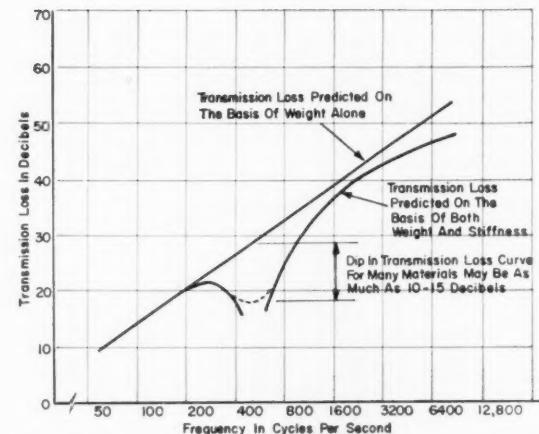


Fig. 2 Effect of mass and stiffness in transmission loss.

(an objective of many movable partition designers), the partition becomes less effective as a sound isolator. There are natural flexural modes of vibration of the panel which coincide with certain frequencies of normal voice and music sound. Stiff, lightweight panels can have greatly reduced efficiency in the middle of the ordinary audible range simply because of the basic interrelation of stiffness and mass. An ideal sound isolating partition might be a rubber sheet loaded with lead shot. This would hardly make a good partition, but it is heavy, and it is not stiff.

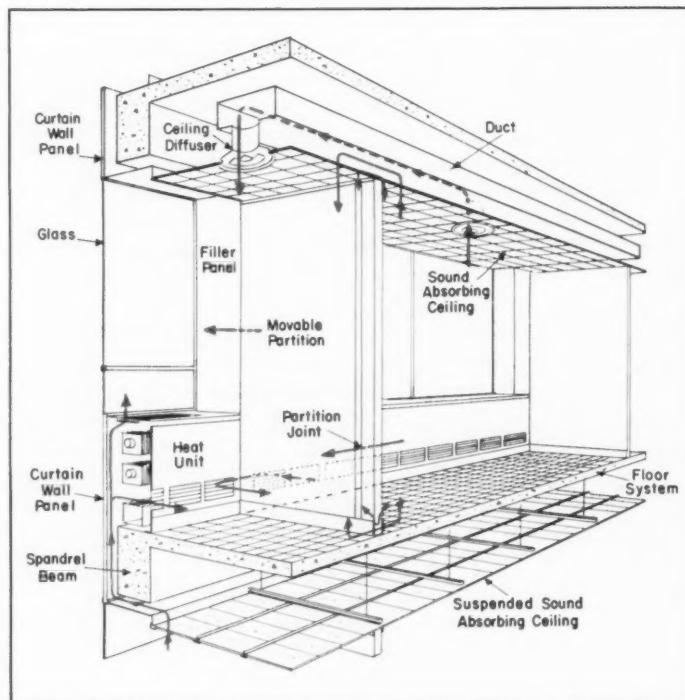


Fig. 3. Advances in structural and mechanical design have added new factors to those which the acoustics consultant must consider in planning an apartment or office building.

Fig. 2 shows the effects of mass and stiffness on transmission loss. Transmission loss is the actual measure of the sound isolating value of the partition itself without regard to how it is installed in the building. We may get more or less actual sound isolation depending on just how the elements are installed. For the sample given (4 lbs/sq ft panel with stiff core and heavy facing) we see that the performance is considerably poorer than we might have expected on the basis of weight alone. The dip of 10 or 15 decibels in transmission loss at approximately 400 cps is quite common in many of our modern partition components, especially those with stiff cores. Some standard building materials, properly used, give a satisfactory balance between acoustical performance and structural requirements — e.g., plaster on resilient clips, or some standard double-skin metal movable partitions.

Problems of the Designer

When we discuss sound isolation, we must consider not only the components of the partition system, but the connections between these components and the rest of the building. A partition that provides reasonably satisfactory isolation between two occupied spaces will transmit roughly 1/10,000 of the incident energy to the adjoining space. That is, it has a transmission coefficient of about 0.0001 or even less.

It is important to understand that leaks, cracks, and holes have a transmission coefficient of one, so no partition system, floor system, or other isolating barrier can possibly do its job if it is not completely airtight and sealed at all connections. Unless these provisions are made in the basic design, the owner will spend a great deal of time and effort after the building has been completed, trying to seal all the thousands of leaks and cracks which nullify the value of the partition components as sound isolators.

To illustrate some of the problems confronting today's building designer when he is asked to provide good sound control in a building, we might examine a typical situation. Fig. 3 shows a section through a typical floor in an office building with lightweight curtain walls covering the structural elements. There are several potential sound leaks:

¶ The spaces between curtain wall panels and structural members are clear paths for sound transmission from floor to floor.

¶ The filler panels between the ends of the partitions and the window mullions, unless perfectly fit, provide direct connection to the adjacent room.

¶ Under window ventilating units are usually continuous along the building. They must be carefully blocked off at each module point to obtain effective sound isolation.

¶ Overhead air supply ducts and the plenum above a suspended ceiling are generally the most troublesome sound transmission paths.

¶ Doors are a designer's headache. Where privacy is required, doors cannot be louvered; often they must be weatherstripped.

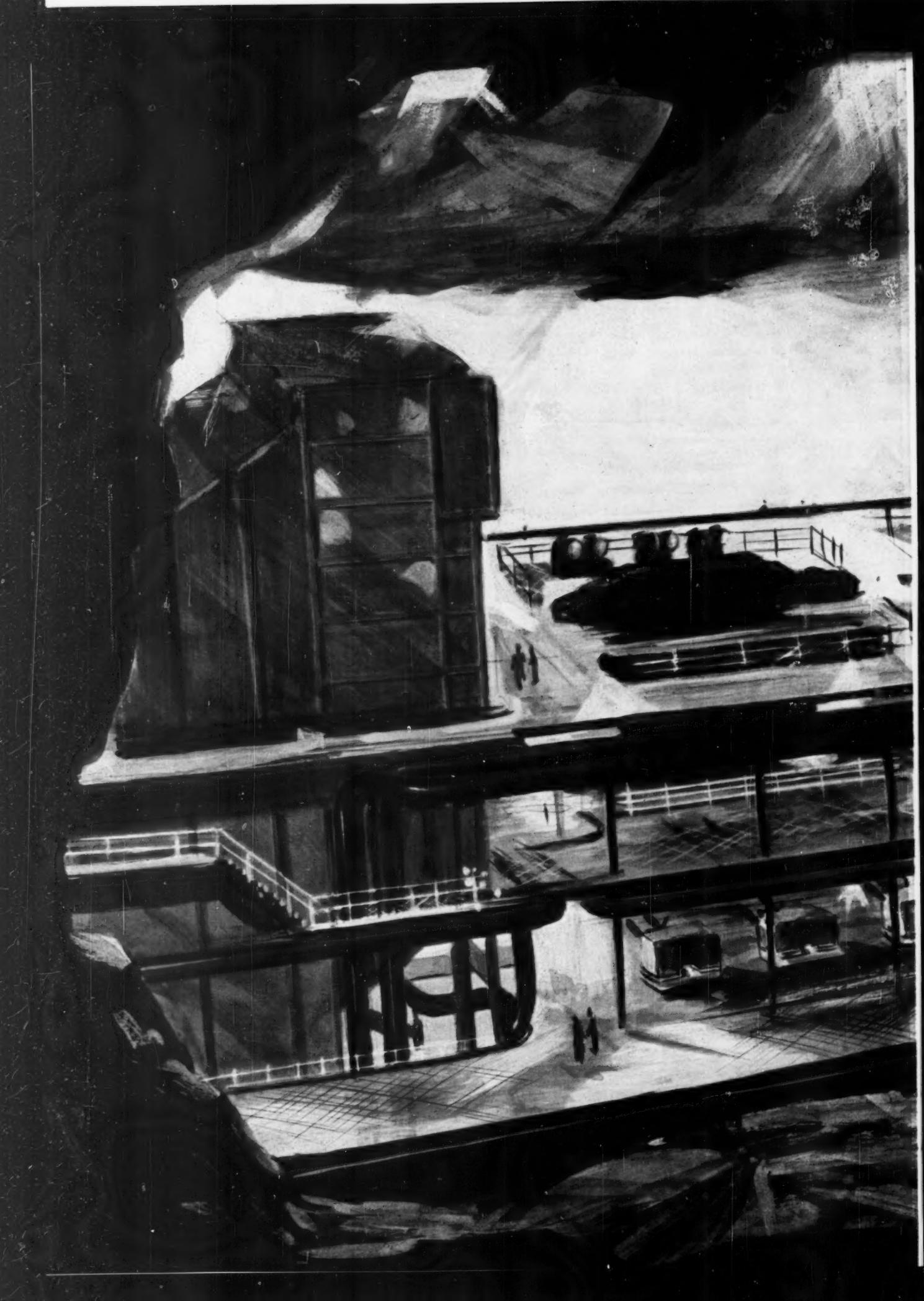
¶ The usual sound absorbing ceiling affords but little sound isolation. Sound from an office can go up through this material into the plenum and come down again on the other side of the partition. Only a few of the ceiling materials now being manufactured combine a reasonable degree of sound isolation with appreciable sound absorption.

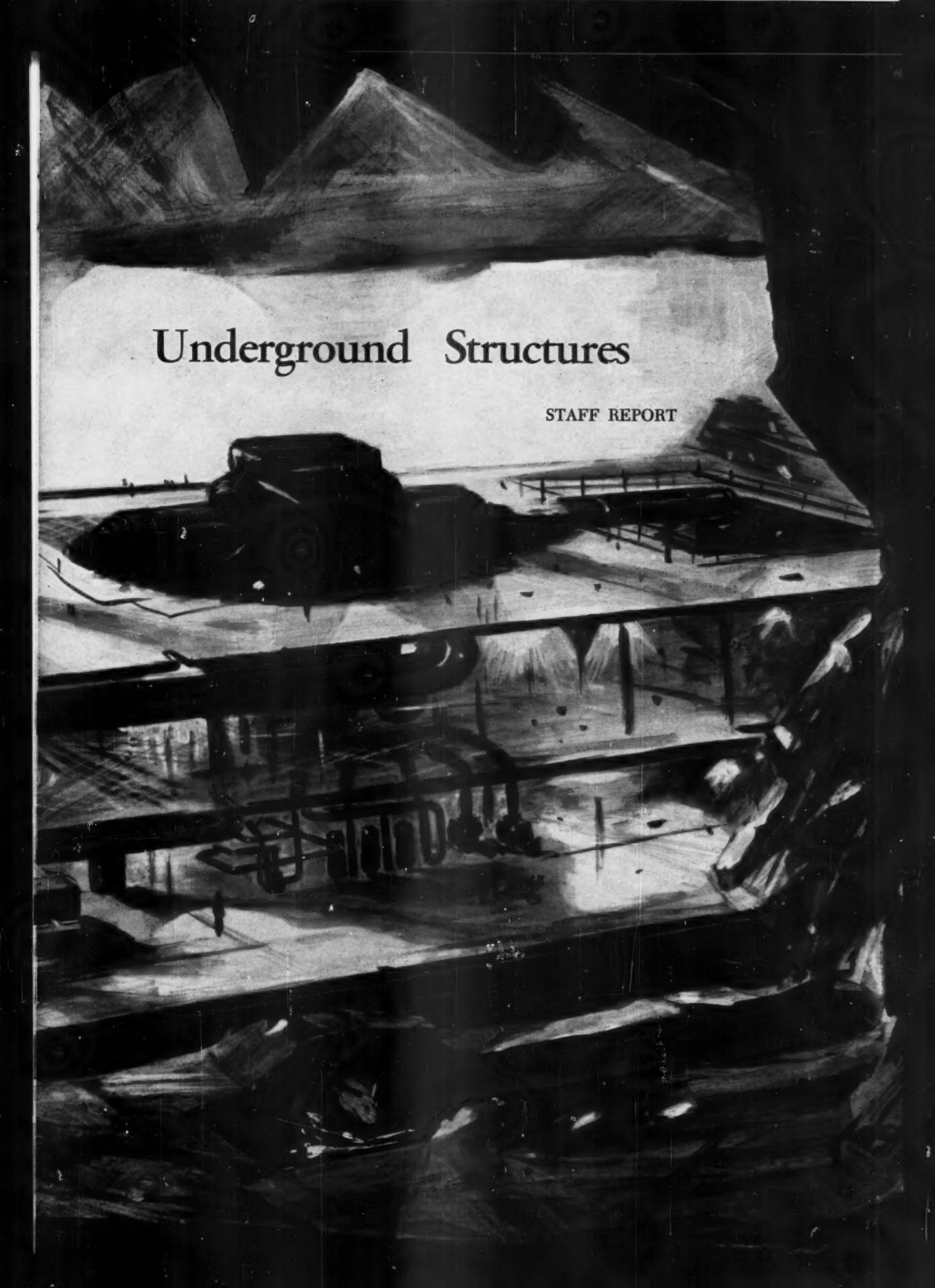
The Partition

In addition to these peripheral paths for sound transmission between rooms, there is the partition itself. If the partition must be movable (and this seems to be an almost universal demand in modern office buildings), it probably will be made of fairly lightweight panels which can be moved easily. These panels will not be very large and will necessarily have a good many joints between them, in addition to connections with the ceiling, floor, windows, service facilities, and any of the other fixed elements of the building.

A number of movable partition systems are available that provide adequate isolation if the background noise in the occupied space is high enough. The component panels are not, however, always connected to each other and to other parts of the building with airtight closures. In the past some of these partition systems have used fairly hard rubber gaskets to join the units to each other; these almost never give an absolutely airtight seal. Obviously, the gasketing must be quite soft and pliant and ought to be realistically sized to take into account the variations in dimension which occur at panel edges and the problems of imperfect alignment. A $\frac{1}{8}$ -in. tubular gasket, of a very soft material like foamed plastic, seems to be about the right size to handle ordinary partition situations. The gasket itself must be airtight, and must be introduced between the elements of a partition at every connection where leakage could possibly become a factor in sound transmission.

The problems relating to the typical office building also show up to a greater or lesser degree in apartments, hotels, hospitals, and schools. This means the importance of good basic planning for acoustics should be recognized today by every building designer. Only by serious attention to the many details of design can we hope to achieve reasonable privacy in our buildings, built as they are with lightweight components. The basic problems of acoustics will not go away; the engineer must solve them. □





Underground Structures

STAFF REPORT

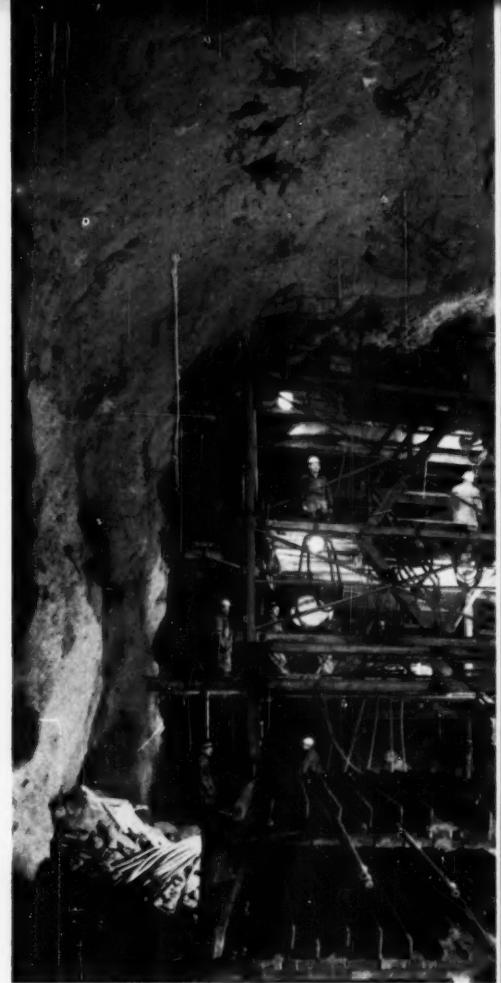


Underground Structures

Staff Report

- The Earth Beneath
- Design Fundamentals
- A Military Necessity
- Power from Caverns
- Dual Purpose Public Buildings
- Deep Storage
- Industry Digs In

The Earth Beneath



UNDERGROUND STRUCTURES, designed with at least an intuitive knowledge of engineering principles, were built by the Mycenaean Greeks. They made frequent use of the corbeled, or false, arch, and they seemed to be particularly pleased with their great underground conical or beehive tombs and storerooms of stone. The Romans built somewhat similar underground rooms, and the early Christian catacombs are amazingly extensive. This tendency to go underground continued through the middle ages.

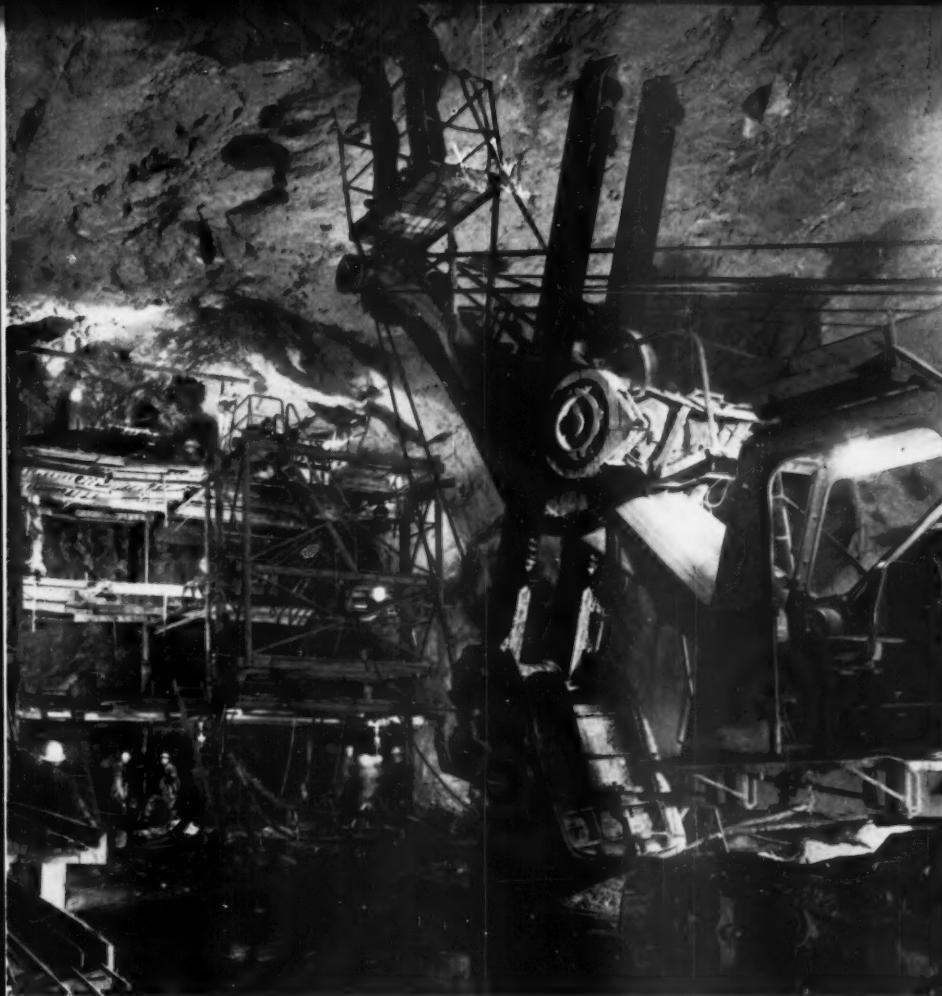
Men still are interested in the subterranean, but few prefer to work or to live therē. Yet, industry has no employment problems in its windowless plants and both teachers and students are reported to be enthusiastic about the new windowless schools in the Southwest. In fact, we often go to considerable expense, and a good deal of trouble, to create a sort of underground environment above the surface of the earth.

The desire to live and work above ground is, however, based on sound economics — sound peace-

time economics, that is. In a series of studies for the Army Engineers, Guy B. Panero studied the cost of putting three types of industrial operations underground, in both existing mine sites and specially excavated caverns. Of these, only a warehouse located in an existing mine would be more economical than a conventional building on the surface. The cost for a typical chemical plant would rise about a third if built in an existing mine site; about 60 percent in a special excavation. A light manufacturing plant built underground also would cost more.

Obviously, at these premium prices, no American industry is going to bury itself without good reason or encouragement from the government.

The Swedes have done it. Their geography and internal economy make it a little less expensive to do so, but mainly they have gone underground because they feel they have lived too long and too close to Europe's wars. But with today's weapons, few nations feel that they can afford to dig deep enough to escape from war. Thus, in the United States, our underground construction program for



Atlas Copco photo

Swedes have pioneered many advances in excavation. Here crew is at work on one of the tunnels for the Harrsele hydroelectric plant on the River Ume. Note men on platform using one man drills equipped with adapters for rock bolting operation.

the military is well advanced. It is in the area of civil defense that we lag, with only a few buildings and underground garages offering a minimum of protection in some of our large cities.

Underground construction has been undertaken for reasons other than fear of war. The water systems of the ancient world went underground to get proper hydraulic gradients and to slow down evaporative losses. In 1825, the crowded streets of London forced the city to build a subway system, and New York City began to think along the same lines by 1864. Today, every modern city has its own little known subterranean world for its sewers, subways, pipelines, and electric and telephone cables.

As land values skyrocket in our metropolitan areas, there is more and more reason to go down as well as up. Thus, Boston is putting much needed parking facilities under its historic Common, and in the Denver area, football games will be played over huge concrete water reservoirs.

Another factor forcing structures underground is purely esthetic. While the United States still has many areas of wilderness, it is different in the

Scottish Highlands. When it was decided to develop the hydroelectric potential in the area, all the power stations went underground, regardless of cost. The people were not willing to see the natural beauty of their mountains destroyed.

Safety, too, has been a factor in opting for underground construction. Shell loading facilities are commonly placed in bunkers or completely buried, and nuclear plants currently are being designed for complete underground construction or with reactors buried deep in steel lined caissons.

It is evident that underground engineering is in transition. In the past, primary consideration was given to getting through the ground with pipes, tunnels, and wells. Today, these are still important — and always will be — but the new engineering emphasis is on the building of structures underground. In the right kind of rock, the cavern walls themselves can form the structural shell. But more often than not, there seems to be a need for a man-made shell integrated with the cavern walls, or even a free standing structure in a hole blasted out deep underground.



Underground Structures

Design Fundamentals

The Basic Principles Involved...

W. W. MOORE

Dames & Moore

THE DESIGN OF structures for underground space involves the same principles of mechanics as any other engineered structure. However, certain factors in the application of these principles become more complex for underground structures, and the degree of indeterminacy is likely to be greater.

It is usual practice to consider lateral and vertical forces imposed on retaining walls or on the roofs of buried structures, but, in the past, the size and cost of these structures seldom has warranted a sophisticated design approach. The factors of safety used in their design could more accurately have been called factors of ignorance. But with the advent of underground structures of greater complexity, and consequently greater cost, more attention must be paid to pressure problems.

It is well known that walled structures that are so rigid they cannot deform will develop higher pressures from earth fills placed against them than will those that permit some small deflection. The phenomenon of arching, which is the tendency for vertical or lateral loads to be carried around a structure by inherent mechanical properties of the earth or rock, also will require greater consideration in future designs. Thus, deeply buried structures need not be called upon to carry the full weight of soils resting on them.

Soil Elasticity

As loads are applied to the earth, the particles of soil below are pressed together, resulting in a downward movement. In fact, the weight of the soil above a level compresses the soil below, but it is often not realized that this process is partially reversible. Subsoil can be compared to a loaded spring, which, upon removal of the load, tries to

resume its original shape. Thus, where a considerable weight of material is removed, the soils at the bottom of the excavation, and for a considerable distance below the bottom of the excavation, try to move upward. For ordinary construction, it is seldom necessary to consider the effects of removing this weight of material, but in large excavations, movements can be of appreciable magnitude, as evidenced by work done on major building sites where upward movements of two to three inches have been measured. These movements of the foundation soils may reduce bearing capacity and increase the tendency to settle.

Water Forces

With the notable exception of dams, structures above the earth's surface generally do not have to withstand water forces. However, problems due to the presence of water always must be considered in underground construction. When structures are built below the ground water level, means usually must be found to remove the water from the excavation during construction, for the spring-like expansion characteristic of soils is often magnified by the presence of water.

The forces that the permanent ground water level will impose upon the structure also must be considered in design. In addition, it must be realized that the presence of water, as well as chemicals which may be dissolved in it, can create a corrosive environment damaging to structural materials.

How Solid Is Rock?

We often use the cliche "solid as a rock," but just how solid is rock? Normally, the elastic properties of rock have little effect on design studies. But look

at what rock may be asked to do in underground structures. In recent months studies for a large aircraft company were made of the feasibility of constructing a high pressure gas storage chamber in subsurface rock. This chamber was to have a volume equivalent to a cylinder of 30-ft in diameter and approximately 400-ft long. Gas was to be stored in the chamber at pressures up to 5000 psi, and with an average pressure of about 3500 psi. Maximum pressures would be maintained in the chamber for several hours or for several days. Sudden evacuation of gas from this chamber, causing a pressure drop from 3500 to 500 psi, would result in an approximate gas temperature change from +80 F to -160 F.

Under the stresses of these pressure and temperature changes, the elastic properties of the rock must be considered. Small fissures or joints in the rock, which ordinarily would be of little consequence, become critically important. The effects of water or chemical reactions on certain rock materials, which are subject to expansion and loss of strength when their environmental conditions are changed, also must be understood. The financial benefits to be gained by these detailed studies can be substantial. In this example, it was estimated that a comparable facility built above ground would cost about \$3½ million. The cost when excavated in rock was estimated between \$1½ and \$1¾ million. Studies of larger units indicate greater economies.

Earthquake Forces

Perhaps nowhere is the contrast between the design of structures above and below the earth's surface more striking than in the consideration of earthquake forces. Building codes often call for the application of static forces equivalent to 2, 10, or even 20 percent of the force of gravity upon structures to simulate earthquake stresses. But how

realistic is such an approach in considering the dynamic distortions that may be imposed by underground wave motions induced by earthquakes — or by extremely powerful bomb blasts? The release of such tremendous amounts of energy can distort an underground structure unless it is designed to withstand terrific pressures or is surrounded by an insulating zone. Actually, it may be simpler to design the structure to accept the distortions imposed, as is being done in the design of a West Coast rapid transit tube. In these studies, it was considered probable that the structure would experience maximum displacements on the order of 1 to 2 feet over distances of 500 to 1000 feet during a major earthquake.

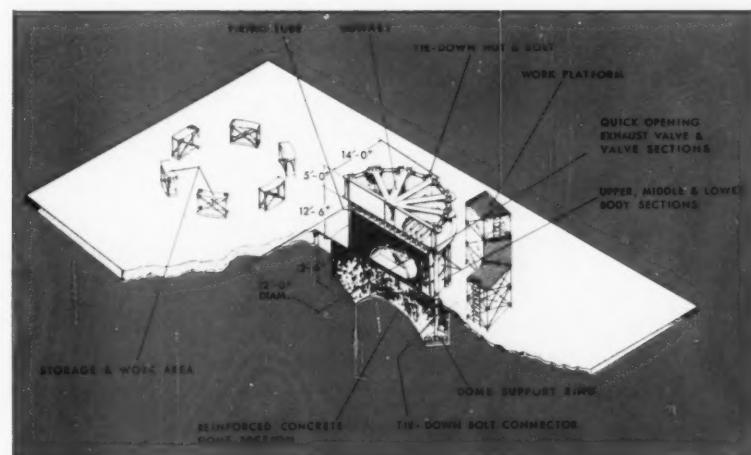
These are some of the important engineering aspects of underground construction. As both military and civilian needs for underground facilities grow, the scope and challenge of the engineering problems also will grow.

Hardened Underground Structures

M. E. WARNER

Roberts and Schaefer Company

THE SCIENCE OF hardened design for underground structures is based on existing theories of structural analysis, augmented by the principles of dynamic analysis. However, the proper application of these design concepts must be tempered by design and construction experience, for there currently is a scarcity of test data. New concepts of design and new operational theories are being promulgated constantly by government agencies and by others working in the field. They present a real challenge to consulting engineers.



Boynton Associates, La Canada, California, designed this dynamic load generator — an important tool in the study of atomic blast effects on structures. It is one of several different sizes and types designed to produce a relatively inertia free dynamic pressure wave or load for testing materials and structures.

The first consideration in hardened design is the determination of weapon yield. This is a matter of high level policy based on considerations of facility dispersal and the relative importance of the structure. The military command involved usually determines the weapon yield by specifying a bomb of "X" megatons, surface exploded at "Y" feet from the structure. From these values the overpressure resulting from the blast wave and the time of duration of the force pulse can be determined. Consideration of properties of the soil surrounding and covering the structure, together with the characteristics of the explosion, permit reasonable predictions of ground motions and pressures for the assumed conditions.

A structure is sufficiently resistant to nuclear attack if:

†The personnel and equipment inside the structure are protected from nuclear and thermal radiation.
†The structure is stable enough to protect personnel and equipment from other injury so they can function normally after the blast.

†Personnel and equipment are protected against the effects of ground movements and accelerations.

Studies indicate that protection against thermal and radiation effects can be had by providing about 15 to 20 feet of earth cover, but with these shallow burial conditions (down to about 50 feet of cover), reduction of blast pressures and ground movements are almost insignificant. Here, then, is the first point at which a critical decision must be made. The depth of burial for the structure must be established on the basis of careful cost studies.

Preliminary Simplifications

Preliminary sizing of the structure is based on static forces, including possible hydrostatic forces caused by ground water. To simplify the problem, the structure may be reduced to a single-degree-of-freedom system by assuming that only the predominant mode of vibration is excited. Two basic ratios then are used as design parameters: the ductility factor, defined as the ratio of permanent deflection to the deflection at yield stress; and the ratio of time of duration of the force pulse to the natural period of vibration of the structure. Adopting a further simplification, that the force pulse is triangular in shape, the response of the structure (i.e., motion or deflection due to dynamic loading) can be determined from charts plotted with the basic ratios as variables. These charts give a dynamic load factor which, when multiplied by the assigned overpressure, gives a design loading.

The values that determine the basic ratios are constants for any given structural element with the exception of the factor for permanent deflection. This factor will vary with the material speci-

fied as well as with the magnitude of permanent deflection which the system can absorb and still remain functional. For elements supporting critical equipment, such as doors and escape hatches that must operate after the blast, a factor of one is generally used. For other items, such as structural steel shells, the factor may be assumed to be 20 or more. The choice of ductility factors must be based on a knowledge of the tolerance of personnel and equipment, as well as on the structural material.

With knowledge of the properties of the blast, together with pertinent data regarding surrounding soils, shock spectra can be worked out and then reasonable approaches to values of ground movements and accelerations can be selected. Shock spectra is the term given to graphs showing a family of curves of movements and accelerations for various depths below grade, plotted against the natural frequency of the structure. Typical spectra are shown in Fig. 1.

Acceleration Tolerance

Test data on human tolerance to acceleration indicates that several g's can be taken for a short duration of time without adverse effects. Manufacturers of equipment for use in hardened structures usually can state the g tolerance of their products. Where practical, it is desirable to shock mount a complete assembly, such as a floor, room, or shaft, rather than to attempt to isolate each piece of equipment. Shock absorbing systems consisting of springs, dash pots, spring beams, pads, or some combination of

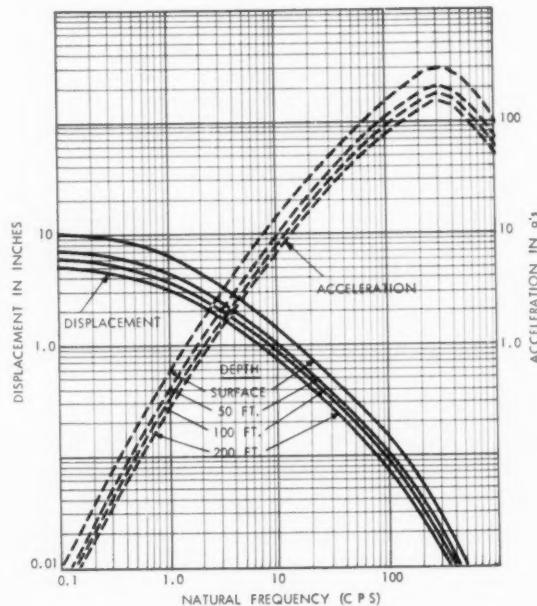
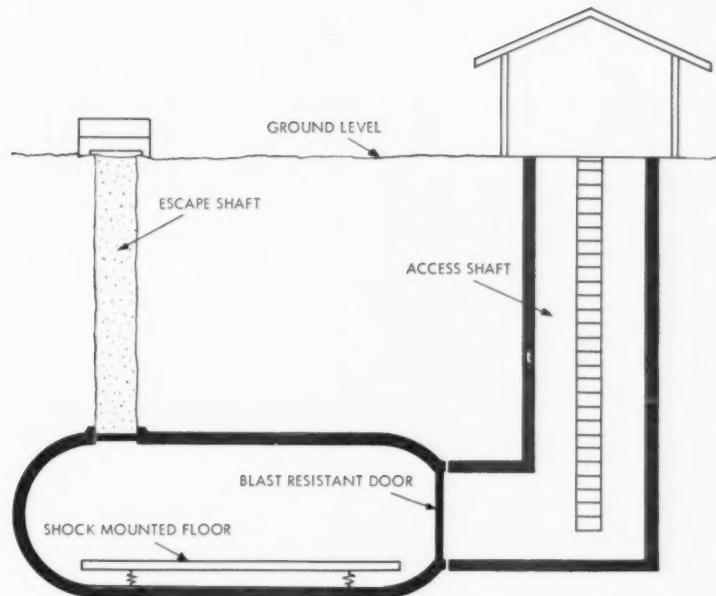


Fig. 1—Typical shock spectra for specific design.



Typical hardened structure with soft access shaft, blast resistant entrance door, and a separate escape shaft filled with sand to withstand blast loading.

these are generally designed to attenuate the acceleration predicted from the shock spectrum to a level in the neighborhood of 3 to 5 g's. This system must attenuate both vertical and horizontal components of acceleration; therefore, mounting of the isolated structure near its center of gravity is a desirable goal.

Other Design Problems

Ground movements of several inches may accompany nuclear blasts. Provision must be made for these movements by including sufficient rattle space around the isolated unit. Utility lines must have flexible connections capable of large deformations in any direction.

Beyond these structural problems the designer of hardened structures also must consider provision for escape, maintenance of proper environment, psychological effects of prolonged burial, and utility requirements for special equipment. A typical example of a hardened structure is illustrated. A "soft" access shaft, a blast resistant entrance door, and a means of escape through a separate shaft (filled with sand to withstand blast loading) are shown. Entrance doors to the hardened facility must be designed to resist the blast pressures, which are often greatly multiplied by pressure buildup phenomena as the wave is reflected from surfaces.

The similarity of environment in a submarine and in an underground structure is obvious. Many studies have been made of the psychological effects on personnel in the submarine service, particularly during the prolonged underwater cruises made pos-

sible by nuclear craft. These studies indicate that life during long term subterranean duty can be made much more tolerable by providing adequate ventilation and air conditioning, carefully controlling ion balance in the air, frequently shifting duty, providing pleasing colors and lighting, and building a strong esprit de corps.

Equipment in hardened structures is likely to have special power requirements and require a high degree of temperature, humidity, and air pollution control. Use of commercial power is advisable, with emergency generators or batteries available. Air conditioning equipment for heating, cooling, or humidification is most economically located above ground, since criteria presupposes a relatively short post attack operational period during which comfort air conditioning would not be essential. Air pollution may be controlled by passing the incoming air through various filters designed to absorb harmful chemical or biological materials as well as radiation. The fresh air supply would be cut off after an attack, with personnel relying on bottled air or an air purifying system.

Plumbing presents special problems of water supply and sewage disposal. Water lines should be soft, with a reservoir available for post-attack use. Sewage can be stored in a tank and pumped periodically, treated chemically with periodic disposal, or handled in a septic tank. If cryogenics (refrigerants and liquid propellants) are involved, problems of piping become technically involved and frequently quite elaborate, but they are not impossible to solve.

AMONG THE MANY problems of detail besetting the designer of hardened military structures underground is the difficulty of bringing access and ventilation openings to the same high level of hardness that can be achieved without too much difficulty for the deep underground structure itself. However, according to Edward Cohen, of Ammann & Whitney, "these difficulties can be overcome, although considerable expense sometimes may be involved."

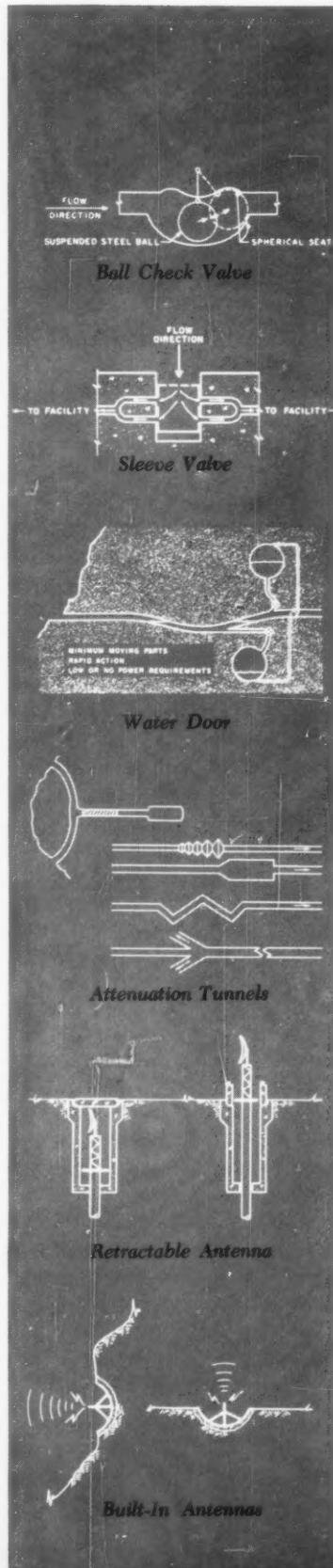
The design of access doors has ranged from adaptations of the heavy doors typical of the modern safe to the use of controlled flooding to provide a barricade of water in a depressed section of an entrance tunnel. These usually are combined with tunnel designs that will fail-safe by collapsing at pressures below those capable of destroying the access doors. Attenuation of blast effects is also an approach being given serious study. Many conventional valve designs have been adapted for automatic closure of ventilation openings. But wherever valves and doors are designed to be controlled automatically, there arises the additional problem of designing control mechanisms also capable of withstanding blast effects.

Communications Problems

Communications also is vital to the effectiveness of the underground military installation. Since much of the necessary equipment is electronic, hardened components and transmission cable are being developed in close cooperation with the electronic industry. Of particular importance are the antennas necessary to radio communication and guidance systems. According to Edward Cohen and Pasquale Di Napoli, of Ammann & Whitney, there are four important methods of providing hardened antenna:

- ¶ Hardening by modifying present designs.
- ¶ Using new concepts and ideas amenable to hardening.

Some Special Problems



¶ Using antennas sheltered from nuclear effects except when in operation, i.e., retractable.

¶ Making use of existing terrain and hardened structures for built-in support.

At the present time, major emphasis is being placed on retractable designs for antenna and the use of suitable terrain. However, studies are being made of antenna encasement in plastic foam, and there is hope that this may be successful for some applications.

Heat and Air

Other major problems for the designer of hardened underground structures are the dissipation of heat and the purification of air when the facility is buttoned-up during emergencies. Heat is generated regardless of the method of power generation during emergency periods when the underground facilities are cut off from normal utility supplies. And, except for nuclear power systems, air must be brought in for combustion purposes. Thus, there is a strong interrelationship between the various utility services required.

The ideal power source for an underground facility during the emergency button-up period, should:

- ¶ Be able to stand idle for long periods without becoming incapacitated or hard to start.
- ¶ Be capable of operation by untrained personnel.
- ¶ Be relatively insensitive to shock.
- ¶ Produce no obnoxious fumes.
- ¶ Present no serious heat removal problem.
- ¶ Provide energy in a suitable form, preferably at a commonly used voltage and cycle.

Such an ideal source does not exist. Thus, the design of an actual power source must be compatible with air conditioning requirements, water availability, heat sink characteristics of surrounding soil or rock, availability of outside air, and a number of other equally significant controlling factors.



Underground Structures



Planes of the Royal Swedish Air Force are hangared in man-made caverns located adjacent to flight runways.

A Military Necessity

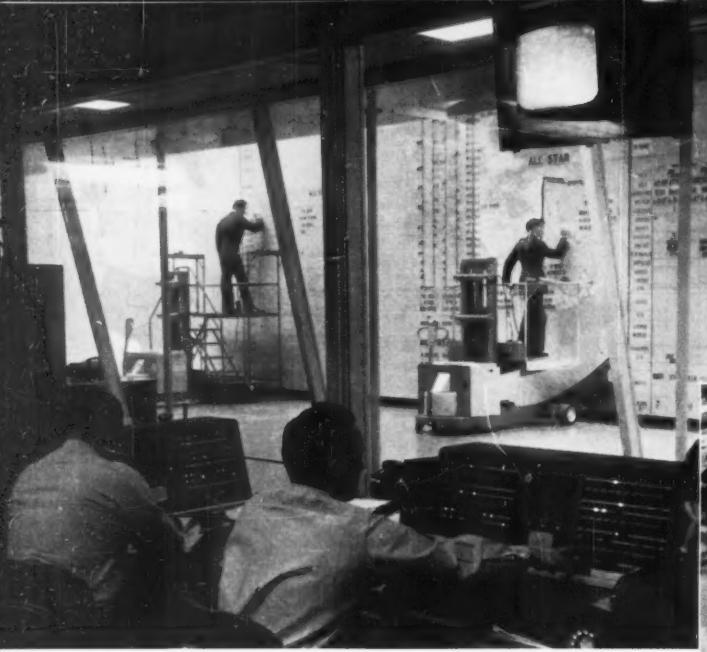
"SOMEWHERE IN SWEDEN," air force planes are buried in deep underground structures. And on the coast, underground shelters and harbors are protecting ships of the Swedish navy. According to Ragnar Widegren, secretary of the Association of Swedish Consulting Engineers, the success of these projects of the Swedish Department of Defense has been largely responsible for his country's further acceptance of underground structures for many civilian needs.

The Strategic Air Command

In the United States the military also is the leader in the design and construction of underground facilities. One of the first was the Strategic Air Command (SAC) Headquarters, at Offutt Air

Force Base, near Omaha. This \$8 million facility, which was occupied in January 1957, was constructed for SAC by the Omaha District of the U. S. Army Corps of Engineers, with the Leo A. Daly Company, of Omaha, providing architect-engineer services. Major elements are administration building and underground command post.

The administration building is of normal reinforced concrete and masonry construction and provides the extensive administrative facilities required for the world-wide SAC organization. The command post, which is completely underground, contains 116,000 square feet of floor area on three levels. It is of heavy reinforced concrete and is hardened to the extent required to resist a heavy and direct nuclear attack.



Strategic Air Command headquarters at Offutt Air Force Base in Nebraska is hardened underground complex designed to be completely self sustaining in the event of nuclear bombing.

Facilities in the command post include a communication center, a global weather center, connections to a world-wide communication system, and a special long distance telephone system connecting SAC Headquarters to each SAC base. The famous "red telephone," used to alert SAC's entire combat force in seconds, is located here.

The main underground structure is 146-ft by 266-ft, and three stories high. Its base is approximately 45-ft below the ground, and the roof has a minimum earth cover 4-ft thick. The roof, floors, and foundation are two-way flat slabs. Exterior walls are built integrally with the slabs. The entire structure was designed to resist both nuclear bombing and hydrostatic ground water pressure.

The mechanical systems of the underground structure are designed to use utilities from the administration building during normal operation, but they are self-sufficient during an emergency.

The plumbing system consists of standard and special plumbing fixtures, domestic hot and cold water, gas systems, and a sewage ejector system. A deep well pump, located in the engine generator room, supplies all the water used in the building during an emergency and supplies water for the engine generator heat-exchangers during power failure periods. All discharge water goes through the base sewer system, but if this is destroyed, the water is discharged to the surface. A sewage ejector system operates at all times.

No space heating is necessary. However, after temporary shutdown, pickup will be accomplished by hot water reheat coils. The hot water normally is heated in convertors using steam from the administration building, but it can be furnished by the discharge from refrigeration condensers.

The main portion of the underground structure is supplied with chilled water for cooling from the administration building, but this can be supplied by four refrigerating units, each with its own chilled water pump. The refrigerating units use water from a deep well for condensing purposes during emergencies, with the water discharged from the condensers going to the reheat coils. A packaged air conditioner in the engine generator room can reduce the ambient air temperatures if this becomes necessary.

An IBM equipment area has a separate, built-up, multizone air handling unit with a direct expansion cooling coil and zone re-heat coils. Two refrigerating units use chilled water from the administration building for condensing, but also can obtain it from the deep well.

Ventilation air is taken in through either of two duplicate air intake systems. Each consists of an intake shaft, pre-heat coils, special filters, a pressurizing fan, and a duct system to distribute the air to each air handling unit. Blast valves on the intake shaft close automatically to protect the system in the event of a nuclear explosion. The air is exhausted through shafts which contain blast-proof poppet valves.

The electrical system is designed to operate from a commercial power supply, but there is an independent emergency standby. Eight transformer stations are provided, each supplied from a primary selective system. When load is switched from one power supply to the other, one of the two primary circuits will receive power before the other. Primary switches at each transformer station are set to provide power to the most critical load first. Two groups of three transformer stations are pro-

vided with secondary switching so that in a group of three transformer stations two may be operated in parallel and the third removed from service.

Titan Missile Facilities

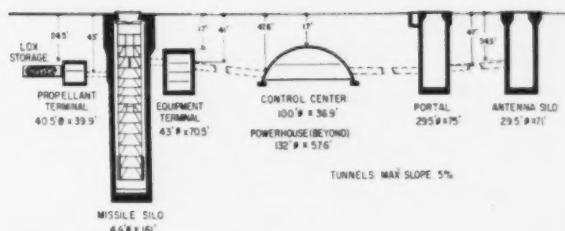
The \$540 million Titan intercontinental ballistic missile base construction program currently under way involves a complex combination of hardened underground structures. Designed by a joint venture; Daniel, Mann, Johnson and Mendenhall and Associates; the project has involved 60 key people from DMJM, The Rust Engineering Company, Leo A. Daly Company, and Mason and Hanger-Silas Mason Company. In addition, a design and office force of 255 was required at the peak of engineering activity.

Each operational squadron for the Titan missile required the design and construction of 10,000 feet of tunnel lined with 5000 tons of steel liner plates. There are nine missile silos per squadron, each 40 feet in diameter and boring into the earth to a depth equal to the height of a 15-story building. Six domed structures are included in each squadron complex, three for power house facilities and three for central command posts.

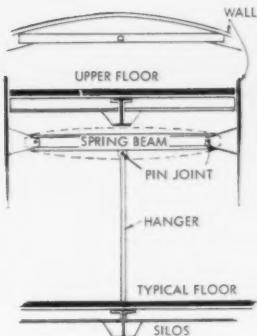
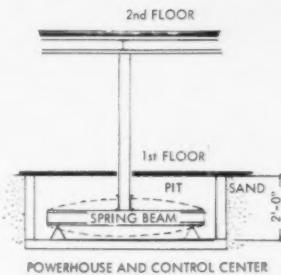
Design studies for the Titan bases included squadron dispersal, access, support, electro-magnetic interferences, geological and hydrological formations, and seismic effects on both structures and equipment. Much of the design was complicated by the Air Force policy of concurrence, under which the design of base facilities and design of the missile itself had to go forward together. The missile silos were actually being designed before the dimensions of the missile itself were established.

Twelve concrete domes, constructed in open cuts, are included in the Lowry Air Force Base Titan project. The six shells housing the power facilities are of reinforced concrete, with reinforcing steel anchored in the footings. This reinforcing, together with footing keyways, transfers stresses induced by normal loading and possible blast loading to the circular footings. To counteract these stresses, high tensile strength wire under tension was wound around the circumferences of the footings after pouring of the structures. This prestressing operation was carried out by the Pre-load Company, Inc., using 25 layers of wire stressed to 150,000 psi. As each layer of wire was put in place, it was covered with mortar.

General view shows construction progress as of February 1960, at Lowry Air Force Base, Titan Missile Site 1A. Dome structures are of heavily reinforced, post-tensioned concrete. Sketches show typical cross section and general arrangement of shock mounting.



SHOCK MOUNTING - STRUCTURES





Pacific Gas and Electric Company's Haas plant is the only large underground hydroelectric station in U.S.

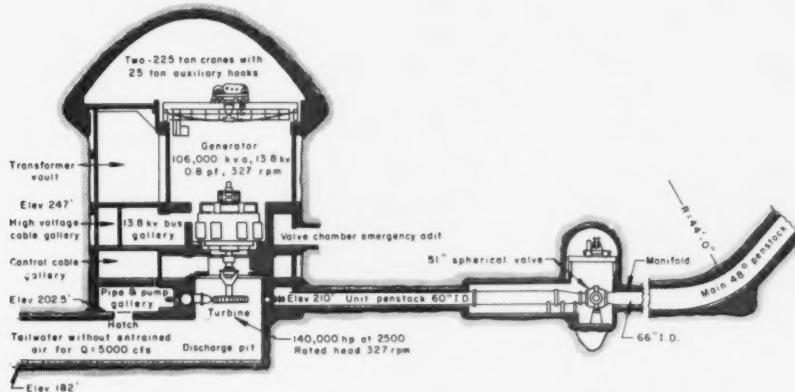


Power From Caverns

THE UNDERGROUND hydroelectric power plants of the Comstock Lode (1890 and 1892) were outstanding engineering achievements of the 19th century. However, they were installed in mines rather than in specially excavated caverns, so they are not usually considered in the historical literature of underground structures. For this reason, the story of underground hydroelectric plants generally begins with the Snoqualmie Falls, Washington, plant which was completed in 1899. By 1904, a small plant was in operation at Fairfax Falls, Vermont, and in 1917 the Pacific Gas and Electric Company completed a plant in California. Meanwhile, Sweden had built two plants, Germany one.

While three of these first six underground power plants were built in the United States, this supremacy was short lived, and it was not until 1958 that the Haas plant of Pacific Gas and Electric was built — the first large hydro plant in the U. S. By that time, the Fairfax Falls plant was history, for a flood in 1927 had destroyed it.

There was little interest in underground power plants before 1946, and only 40 had been built. Today there are over 300, and many more are in the planning or construction stage. Yet, the Haas plant is the only new one in the U. S. There are many reasons for this. One is simply a matter of geography and geology; another is economic. An



Transverse section shows general arrangement of Aluminum Company of Canada's (Aluminium Limited) Kemano powerhouse. Present installed capacity is 1.05 million hp—the world's largest.

underground plant can be considered only when a proper site is available. Then, the cost advantage of reducing the quantity of construction material must be weighed against the disadvantage of greater construction manpower requirements. In this balance the underground plant in the U. S. is likely to be found wanting, economically. And while it is true that our power companies are backward in recognizing some important advantages of underground plants, a number of U. S. consulting engineers not only are abreast of current developments — they are leaders in the field.

With the rapid development of more efficient tunneling and excavating methods, the economic situation is changing. It is this change that made possible the Haas plant and is the cause of the growing interest in Alaska, which, according to the Federal Power Commission, may have as much as 20 percent of the undeveloped hydroelectric potential of this country. In future power demands, this may become an important factor. Though we have developed three times as much hydroelectric power as the Russians, the fact remains that they have three times as much potential. If underground plants will allow maximum exploitation of this power source, both nations will build more.

Although it is claimed, almost without exception, that the underground plants built since 1946 were constructed for purely economic reasons, wartime security probably is involved. Italy leads the world, with Norway, Sweden, Switzerland, and France following in order — all obviously security conscious. Aside from economy and war, there are good reasons for building underground plants. In the Scottish Highlands — preservation of natural beauty, in Sweden — lack of suitable surface building sites, and in other areas — extreme climate conditions or danger from avalanches.

The world's largest underground plant was built by the Aluminum Company of Canada, 500 miles north of Vancouver, British Columbia. Designed by International Engineering Company, Inc., the

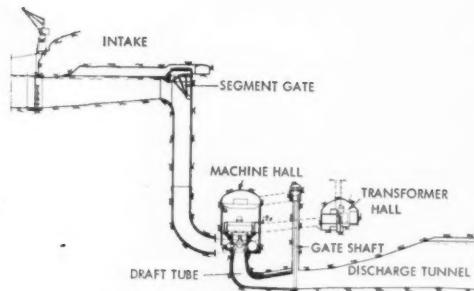


Kemano powerhouse is supplied with water by a 10-mile tunnel running from the reservoir to penstocks.

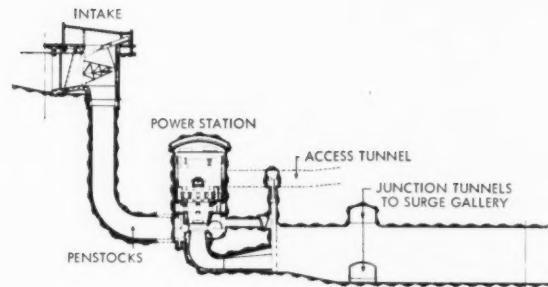


Aluminum Limited photo

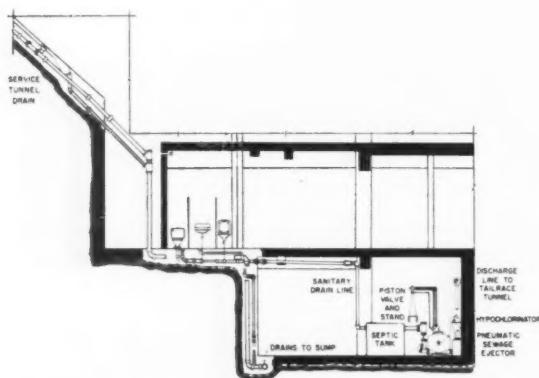
Kemano power chamber is 700-ft long, with a cross section 80-ft wide by 120-ft high to top of arch.



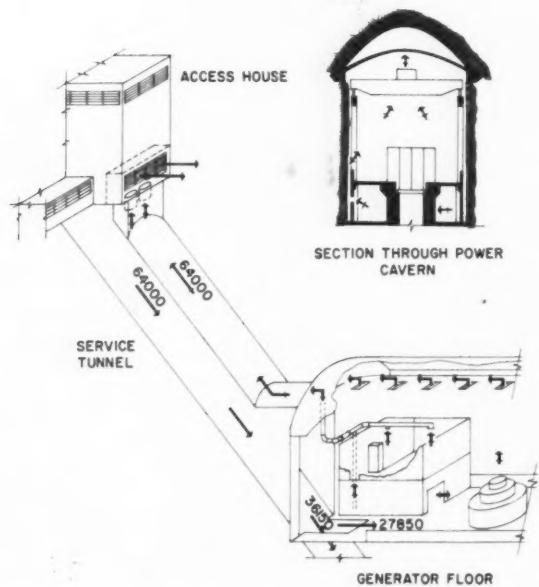
Stornorrfors hydroelectric plant has three turbines installed, with provision for a fourth to bring capacity up to 500 megawatts. Power house is in a rock chamber 407-ft long, 61-ft wide, and 94-ft high.



Harrsele plant has three vertical shaft Francis turbines which produce a total of 200 megawatts. Power house roof has concrete arches cast against rock, with an inner ceiling of precast concrete arches.



Details of sewage treatment system installed at the Hanabanilla hydroelectric project located in Cuba.



General arrangement of ventilation system for Hanabanilla plant. Two, 32,000 cfm fans exhaust air.

plant has an ultimate output of 1200 megawatts. Seven vertical shaft Pelton turbines are currently in operation with a capacity of 1.05 million hp. (See CONSULTING ENGINEER, August 1954.)

Swedish Hydropower

Private interests have shared about equally with the Swedish State Power Board in the development of both hydro and steam power in Sweden. Currently, there is a great deal of activity along the Ume River, in northern Sweden, with the Stornorrfors and Harrsele plants the largest of those already completed. With its rated capacity of 375 megawatts, Stornorrfors is the largest in Sweden. The Swedish State Power Board plans to add a fourth turbine to bring it up to 500 megawatts. Harrsele, with three turbines and a rated capacity of 200 megawatts, is owned by Harrsele AB, a combination of forestry and power interests. Consulting engineers on this project were Vattenbyggnadsbyran (VBB), Stockholm, with Frithiof Hallagen and Daniel Noren for general layout and civil engineering works, and Birger Norsell and Bertil Hagstrom for the mechanical.

The Stornorrfors power house is in a rock chamber 407-ft long, 61-ft wide, and 94-ft high. The roof is gunnite lined with anchor rod reinforcing. Longitudinal walls were placed with sliding forms and tied to the rock with widely spaced struts at two lower levels and continuously at the top. Crane rails are mounted atop the walls. It is interesting to note that Stornorrfors was, until recently, the biggest underground plant in the world. However, the generating rooms of the new underground, 700,000 kw Stenungsund steam power plant are larger. Each of its six generating rooms were made 409-ft long, 80-ft wide, and 109-ft high.

Harrsele has a power house which is 257-ft long, 52-ft wide, and 106-ft high. The roof has concrete arches cast against the rock, with an inner ceiling made of precast concrete arches set by traveling

crane in poured concrete abutments. The crane beams are mounted on supporting concrete columns. Three vertical shaft Francis turbines provide a total of 200 megawatts.

Other Important Projects

The \$15 million Hanabanilla project in Cuba, and the \$52 million Binga project in the Philippines, have both drawn heavily on U. S. engineering through the employment of Tippets-Abbett-McCarthy-Stratton. In Cuba, TAMS handled design and construction supervision for the owner, Primera Central Hidroelectrica Cubana, an agency of the Cuban government.

On the Binga project the firm worked with the Engineering and Development Corporation of the Philippines as consultants to the engineering staff of the National Power Corporation.

Harza Engineering Company is another U. S. consulting firm that has been active in the field of underground hydroelectric power plant design. The Ambuklao project, in the Philippines, was completed in 1957, with a capacity of 75,000 kw. Earlier Harza designed the Guayabo station, in El Salvador, with an initial capacity of 45,000 kw, and provision for an ultimate 75,000 kw.

According to T. A. Lang, of Bechtel Corporation, formerly associate commissioner of Australia's Snowy Mountains Hydroelectric Authority, the huge Snowy Mountain scheme involves a staff of 1200 professional, technical, and administrative personnel. It ultimately will have an installed hydro capacity that will exceed TVA's by 12 percent. Most of the construction work has been done by Norwegian, French, and American contractors.

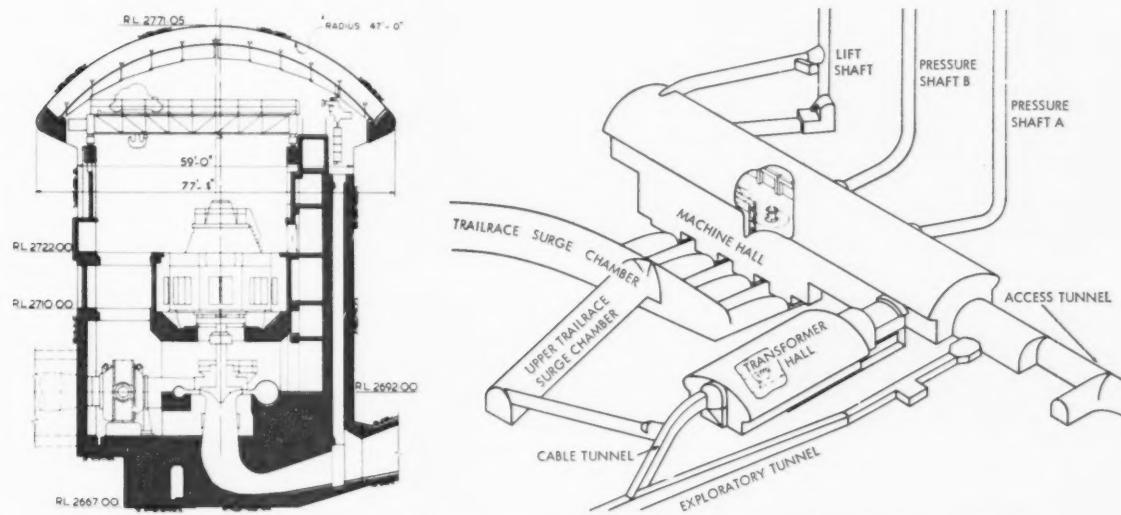
Eventually, there will be 7 major dams and 15 power stations. The Tumut underground power station (T 1), with a capacity of 320,000 kw, is in operation, and the 280,000 kw T2, also underground, is approaching completion.

Scotland's Underground Interiors

When the possibility of developing the hydro potential of the fast flowing rivers of the Scottish Highlands was first explored, it was met with tremendous public opposition. It was feared that the beauty and grandeur of the mountains would be scarred by ugly power stations. As a result, the North of Scotland Hydro-Electric Board decided to go underground wherever possible. At present, there are three major underground power stations in Scotland, a fourth was built on a hillside by the cut and cover method, and several are in the planning stage.

At Ceannacroc, which was undertaken in 1957, the station is equipped with two vertical Francis turbines rated at 16 and 4 mw. The switchgear is housed in a small stone building erected at the tunnel entrance. The rock conditions in the turbine hall made it necessary to stabilize the roof with a concrete vault, to line one gable with concrete, and to apply an artificial surface over part of the other. It was found feasible to leave the rock exposed over practically the whole length of both upstream and downstream walls.

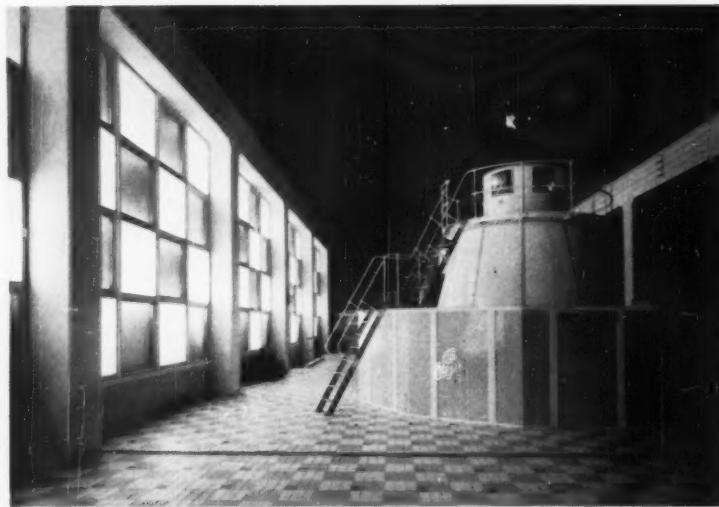
Practically all water seepage was eliminated from the concrete lining of the vault and gable, so that surface staining is not a serious factor. It was decided to paint the vault white so that it would function as a reflector for the main fluores-



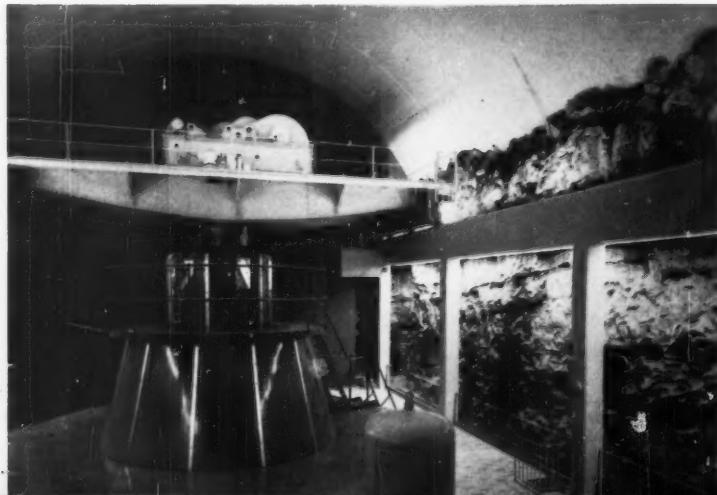
Powerhouse section and general arrangement of the T1 station of Australia's Snowy Mountains scheme.



North of Scotland Hydro-Electric Board made extensive studies to provide attractive interiors for its underground plants. This view of St. Fillans plant shows bare rock at north wall as seen from access tunnel.



Scotland's Glenmoriston station uses backlit glass and plastic panels to hide rock wall. Panels are set in wood frames mounted against crane beams and their supporting columns.



Ceannacroc station uses indirect lighting installed behind concrete crane beam. Good reflection is obtained from white vaulted ceiling as well as the bare rock wall itself.

cent lighting concealed behind the crane beams. Reflected initially from the ceiling, the light also is diffused by means of secondary reflection off the white tiled floor. A lesser source of light comes from other fluorescent tubes, also concealed behind the crane beam.

In order to counteract the sense of proximity of the rock face as seen from the main floor area, a simple wrought iron balustrade, set on a raised curb forming the edge of the tiled floor, was placed between the columns. The delicate upright balusters were painted white and the handrail a pure yellow. This age-old device, long used in film and stage design to create a sense of distance, was most successful at Ceannacroc. This led to its incorporation at other stations.

The architects felt that the concrete-lined gable should be painted a warm color in the terracotta range in order to counteract a sense of chilliness induced by the fluorescent lighting. Having observed the stimulating effect of limited areas of strong color in the Maggia Valley underground stations in Italian Switzerland, as opposed to the somewhat cold and sanitary effect of grey-green in underground power stations elsewhere in Europe, the architects selected a rich terracotta color for the gable wall, and a brilliant oriental blue for the two turbine casings set in the middle of the white and grey-green patterned tile floor.

St. Fillans underground station, which was started in 1958, is much smaller, and while it contains only one vertical generating set together with control panels and other technical equipment, it could have looked rather overcrowded. Interior appearance also was affected by two arched recesses in the walls at both ends.

In view of this, the Ceannacroc approach to internal treatment had to be varied. As a light-reflection factor the concrete vault had to be discounted completely, since the entire surface was coated with a dark bituminous paint in order to conceal staining caused by moisture penetration. Another factor was the safe limits to which the rock face could be cut back on the side walls which made it impractical to house the fluorescent lighting out of sight behind the concrete beams. Instead, perforated masks and metal louvers were installed over the complete soffit of the beam and directed obliquely onto the rock face while, at the same time, shedding direct light into the area of the turbine hall. The floor of the hall was covered with white and grey tiles, to make the most of the available light.

Glenmoriston, also started in 1958, is the largest of Scotland's three underground power stations, being equipped with two, 16 mw vertical turbines. The dominant interior factor at Glenmoriston was

the doubtful nature of rock which made concrete lining necessary throughout. Concrete walls provided on three sides have an inner lining of aluminum sheeting. Seepage of water, with accompanying staining, has been persistent and although a suspended ceiling was not required, the condition of the concrete vault was such that it had to be painted with black bituminous paint.

Under these circumstances, the architects decided to treat the interior asymmetrically. On the upstream wall a series of timber frames were fitted into the 16-ft spaces between crane beam columns. Each frame was subdivided into 4-ft squares, into which translucent and cross reeded glass, arranged alternately, were fitted. Fluorescent tubes were installed behind the translucent panels.

As an additional baffle to hide the stained concrete lining, sheets of white-painted plywood were installed behind the cross reeded glass. The squared pattern of the lit screens seen in perspective along the length of the station lends scale to the whole interior, and a pleasant, tranquil light is shed across the station. The concrete crane beam structure is white and the wooden screens are painted very pale grey to obviate undue contrast between the lit panels and the framing.

For the downstream wall, an entirely different approach was adopted. Lighting here has two distinct functions. It lights the dials on the control panels between the columns and it sheds general illumination on the painted aluminum lining, set well back behind the crane beam structure. Accordingly, a continuous masked strip light was fitted on brackets along the top of the control panels, shielded from the eye. The wall in the background was painted a deep midnight blue so that the maximum sense of space was induced beyond the white painted crane beam structure. The aluminum-lined gables at each end were painted a brighter blue.

It would have been possible to carry out the notion of a conventional above ground structure by forming real windows looking out onto a brightly lit mountain landscape painted on the concrete lining. This has been done in certain underground power stations in northern Italy, but such fantasies seemed alien to the plant's functional approach, and no such artificial environment has been found necessary in thousands of windowless industrial plants. So, instead, the engineers — Sir William Halcrow and Partners, and Kennedy and Donkin — working in close cooperation with the architects — Hurd and Begg — simply tried to avoid designs that might encourage employee claustrophobia and, on the other hand, encourage in any practical way a feeling of spaciousness and above ground freedom.



The Katarina underground bomb shelter on the south side of Stockholm doubles as a garage in peacetime.



Underground Structures

Dual Purpose Public Buildings

"WHILE ADEQUATE civil defense has a long way to go to become a reality in most parts of the United States, a few localities have started planning for area evacuation, emergency and disaster aid, and shelters for vital service." This was the introduction to an article on underground operations center design for civil defense in the April 1958 issue of CONSULTING ENGINEER. It is as true now as it was then.

According to studies by Guy B. Panero, Engineers, it would cost \$680 per capita, or a total of \$2.7 billion, to provide shelter for the whole population of Manhattan at an 800-ft shelter depth, with a 30-minute warning before enemy attack, and provision for 90-day occupancy. Admittedly, this is an expensive proposition — especially if extended to other large American cities. However, something less than this near ideal protection can be achieved at considerably lower cost through the inclusion of shelter facilities in public buildings.

W. T. Rolfe, of the architectural and engineering firm of Colemon and Rolfe, has proposed the construction of underground schools that could

serve also as civilian shelter areas. This might cut the cost of both schools and shelters by combining them. The Office of Civil and Defense Mobilization currently is studying this approach.

Hardened Communications Centers

Civil defense is dependent on the maintenance of communications, and this was considered by the Borough of Richmond, New York, in the construction of its new Central Fire Communications Building. Mechanical engineering consultant on this project was Syska & Hennessy, with Eipel Engineers doing the structural. Realizing that the cost of a blast and fallout resistant structure above ground would be excessive, it was decided to build a modified one-story structure above ground with two additional levels below grade. Added safeguard was provided by locating the building on the lee side of hills to afford protection from probable ground zero blasts.

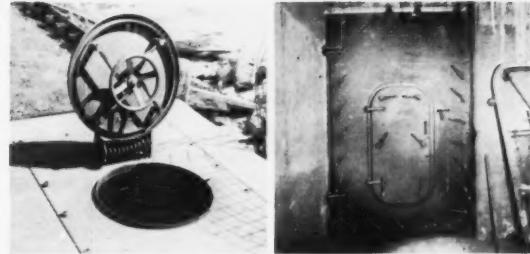
The first floor is of modified conventional construction including large glass areas and bar joist framing with precast concrete planks under normal

New central fire communications building of the Borough of Richmond, City of New York, has conventional first floor construction with two underground levels designed for bomb resistance. Isolated pill boxes supply air to concrete intake ducts. Exits from subbasement area are protected by Navy type gasketed bulkhead, water tight doors of heavy steel.

built-up roofing. This light construction is designed to yield easily to blast pressure thus minimizing effects on structural elements. The floor slab is of reinforced concrete construction designed to sustain a live load of 300 psf.

The basement floor slab, which is the roof over the subbasement emergency operations center, also is designed for a live load of 300 psf, but this slab was provided with membrane waterproofing and a 2-in. protective coat of cement. Floor drains were located on the basement floor level in various areas to serve as roof drains should the main roof collapse. It was assumed that the first floor slab would remain intact after an atomic blast, but the basement floor slab was designed to take the load of both the collapsed roof and the first floor slab.

The subbasement is a complete emergency operating center. It will normally be supplied from the existing street utilities, but in an emergency it can operate independently from the upper sections of the building, with emergency diesel generators, large underground water and oil storage tanks, and year round air conditioning and ventilating.



Air conditioning and ventilating systems are designed to supply fresh air from a plenum chamber provided with radioactive decontamination type absolute filters, emergency automatic intake dampers, and three reinforced concrete supply ducts. These three supply ducts lead to isolated concrete pillboxes on the lee side of the site. The exhaust air is used first to cool the diesel generators before being discharged into a plenum chamber which exhausts through reinforced concrete ducts.

All exits from the subbasement area are provided with Navy type gasketed bulkhead watertight doors. Food storage, dormitory space, toilets, and shower facilities are also provided in the subbasement area.

St. Louis Fire Alarm Center is underground primarily because of tornadoes and a desire to preserve the natural beauty of the area. However, consideration was also given to blast resistance and nuclear fallout protection.



The St. Louis Fire Alarm Center is underground also. While the reasons for going underground were primarily the preservation of the natural beauty of the area and the danger from tornadoes, consideration was given to blast and fallout protection in the event of a nuclear weapon attack. General consulting and structural engineer on the project was W. E. C. Becker; mechanical and electrical engineer, John D. Falvey.

The building rests on a foundation of drilled concrete piles carried an average depth of 15 feet to solid rock. Its structural shell is 12-in. reinforced concrete sheathed in a waterproof membrane. Except for the facade, the entire building is earth covered.

Because of the sensitive electronic equipment housed in the building, complete climate control is required. Recirculation is determined by the outside air temperature, and any fresh air drawn into the system is heated or cooled and humidified or dehumidified as required, after filtration. Two utility lines provide electricity, with automatic switchover in event of normal supply failure. When utility service fails, a diesel generator takes over.

Underground Garages

The two level garage in the Rochester Civic Center is another structure that could be readily converted into a public shelter. Charles H. Sells, Inc. was the consultant for the city and county and coordinated the project. Architects were Voorhees Walker Smith Smith & Haines with Faragher & Macomber. Despite mud seams in what preliminary test borings indicated as solid rock, footing problems were solved and construction completed six months ahead of schedule. Although it had been planned in the initial stages to cover the garage with a deep earth fill, it finally was completed with granite paving and some landscaping. Thus, it would be necessary to increase the fill to make the garage an effective bomb shelter. Utilities for shelter use are available, but not installed.



John Graham and Co. designed San Diego's College Grove Shopping Center which includes long tunnel for truck deliveries, utility lines, and emergency exits.



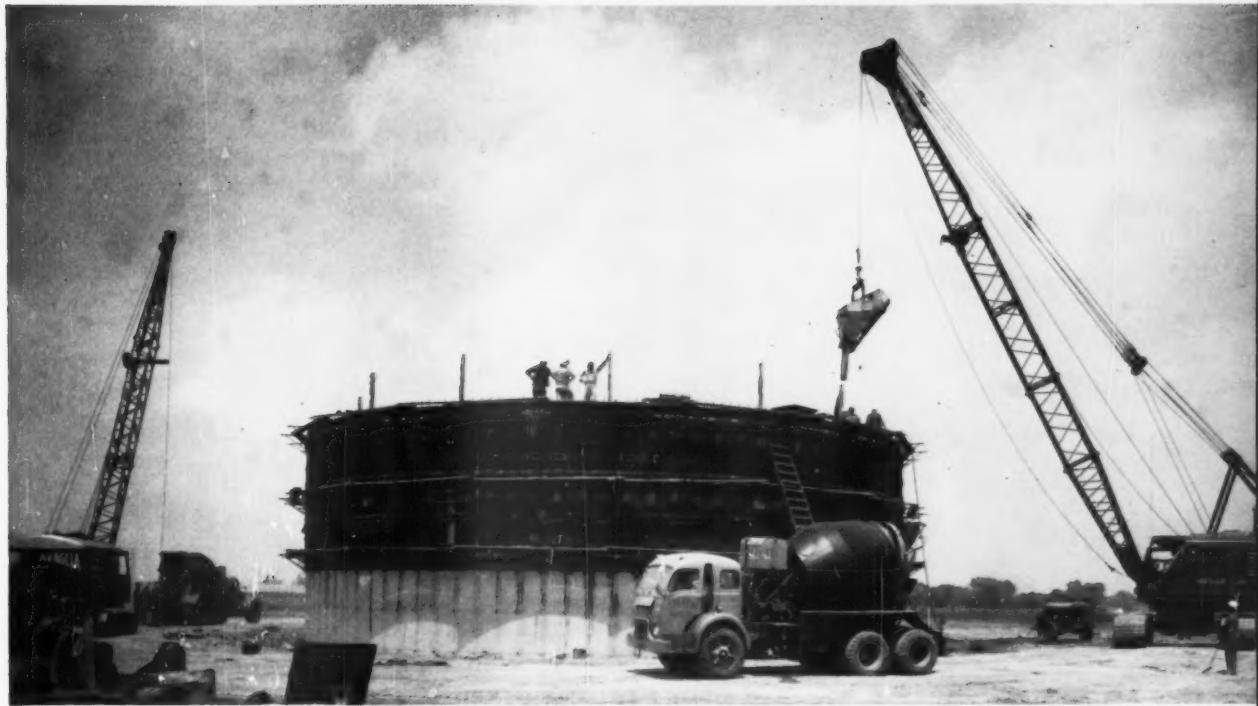
San Francisco's Brooks Hall underground exhibit area.

The Boston Commons Garage, also a potential shelter, has been described as a submerged bathtub. Since the water table is only 8-ft below the surface, 5000 piles were sunk into hardpan to hold the three level underground structure in place. The 1500-car garage was designed by Welton Becket and Associates as the first stage in a development that eventually will accommodate 2500 cars. Associated with Becket are Cosentini Associates, mechanical engineers.

Other Public Buildings

Brooks Hall, in San Francisco, is designed to supplement the existing Exposition Auditorium with an underground exhibit area. The 280-ft by 320-ft structure required 158,100 cubic yards of excavation. Walls, floor, and roof are of reinforced concrete with prestressed, precast concrete members over the truck ramp. The entire structure is enveloped in a waterproof membrane of three felt layers mopped with tar and asphalt. A 2-in. layer of asphaltic concrete was placed over the membrane below the bottom slab, as well as on the roof, to protect the membrane during the placement of concrete for the foundation slab and fill for the roof. H. J. Brunnier was the structural engineer; De Leuw, Cather and Company, the mechanical, electrical, and traffic engineers.

The National Library of Medicine, being built by the General Services Administration, is an unusual if not strictly an underground structure, since three full floors are located below ground. Unusually heavy flat slab construction has been used, and the lower floors are available to provide shelter against radiation, although no provision was made for blast effects. Pant columns were used to conceal air conditioning duct work, and electrical lines are run in the slabs. Severud-Elstad-Krueger-Associates handled the structural design, and James Mongitore Associates the mechanical-electrical. Architect was O'Connor & Kilham.



Wayne County water supply system has 65-ft diameter caisson with 5-ft thick walls in low lift pumping area.



Deep Storage



Base slab construction for Wayne County open caisson.

UNDERGROUND STORAGE is sometimes necessary and occasionally economical. Underground water reservoirs and sewage treatment plants and underground storage of flammable fuels and caustic liquids is common. In the U. S., use of abandoned mine sites has proved economical for storage of food and some manufactured products and their components. Abroad, even greater use is being made of old mine sites. Thus, underground construction for storage purposes is well established.

One of the interesting sections of the Wayne County water supply system, designed by Giffels & Rossetti, is the low lift pumping area. Here a 65-ft diameter caisson with 5-ft thick walls was sunk to a depth of 63½ feet to receive water from a gravity flow tunnel under the Detroit River.

Twelve soil borings were taken at the location of the caisson, eight outside the periphery and four inside the caisson location. Borings were



Prestressed concrete and steel tanks before burial.

carried 20 feet into rock. From these borings a check of the shear value of the soil used in the design computations and elevations at the top of hardpan and rock were obtained. The original borings taken at the site, and the subsequent borings at the caisson location, indicated sulfur water under artesian head in the upper portions of the rock. To seal off this water, the 12 borings at the caisson location were filled with grout applied under pressure.

The caisson was constructed using the open caisson method. As clay was excavated from the open well, the caisson settled under its own weight. Additional lifts of concrete were placed in 10-ft high increments as the caisson was allowed to settle. Final position of the caisson was well within desired location limits.

A temporary pressure relief vent was installed in the base slab to relieve any hydrostatic pressure that may have developed after the pressure grouting. Five permanent pressure relief lines were constructed inside the interior walls. At the top of the walls, provisions were made for pumping connections, and the temporary vent in the base slab then was sealed. Until recently, when the tunnel connection was made, the caisson was partially filled with water to eliminate buoyancy.

Storing Water Underground

Going underground can create serious construction problems. For example, when the Hillcrest

Reservoir was begun in southeast Denver, unrecognized soil conditions made it necessary to change the whole concept of the floor design. When shale material, exposed by excavation, became wet to a depth of 1- to 4-ft, it began to swell. Measurements at some points in the exposed foundation area showed as much as a 4-in. rise in ground level.

At this point, the firm of Ketchum, Konkel & Hastings was retained to study the foundation conditions and propose a redesign of the reservoir. The result was a unique thin shell floor and flat slab roof, with the floor system completely isolated from the swelling shale.

The final floor design consists of a series of continuous barrel shells with 20-ft chords and a rise of only a little more than 2-ft. Since the shells could be supported on rather short drilled caissons, their location on 5-ft centers was not prohibitively expensive. In addition, the shell design used most of the steel purchased for the original design — an important consideration, since it was already on the job site.

Maximum weight of water on the barrel shells is created by a depth of 23-ft, but the highest stresses encountered were from the reactions of the shores while placing the flat slab roof. The flat slab foundations which support the outer and center walls of the reservoir basins were also a part of the redesign of the reservoir. They were cast on 4-in. thick cellular paper to allow for swelling of the soil below. Provision also was made for differential settlement in the connections of conduits to the main basins. Another unusual feature of this \$1 million reservoir is that its 209,000-sq ft area will be earth covered and a part of it used as a football field.

Springfield, Massachusetts, is another community using underground construction. Presently being installed there are the world's largest prestressed water storage tanks. They will be backfilled and covered with a 2-ft layer of earth. In contrast to an old rectangular tank with tapered walls that are 3-ft thick at the base, the new, prestressed circular tank walls have a uniform thickness of 18 inches. Floor slabs are 5-in. thick and the column supported roofs will be 9-in. thick. Each tank will hold 15% million gallons of water.

Clinton Bogert Engineers designed the tanks. Prestressing of the walls was done by the Preload Company, Inc. More than 1000 wraps of wire were applied by a self-propelled wire winding machine suspended from a carriage that rode around the tops of the walls. Wire was drawn from a diameter of 0.236-in. to 0.208-in. as it was wrapped, giving it an initial tension of 150,000 psi. Four layers of wire were applied at the base and only one at



Circular water tanks for Springfield, Mass., will be buried under layer of earth after placement of cover slab.

the top. On completion of the prestressing operation, the wires were covered with a layer of mortar pneumatically applied.

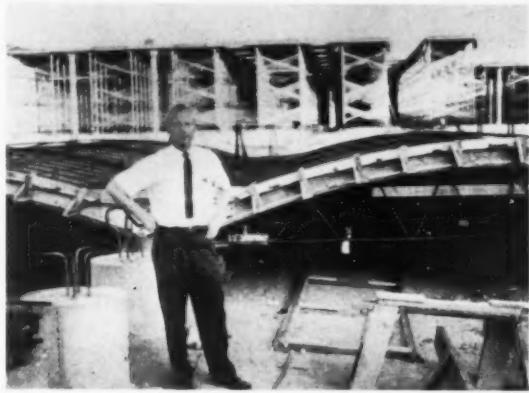
Buried Fuel Tanks

On the West Coast, the Military Petroleum Supply Agency is storing aviation fuel for the Air Force in 12 steel lined, prestressed, concrete tanks. The completed structures are buried by a 4-ft covering of earth. Each tank has an inside diameter of 122½-ft, a clear height of 40-ft, and a storage capacity of 83,500 barrels. Tanks are absolutely leakproof and capable of withstanding the effects of an atomic explosion.

Bernard and Ancira was the consultant on the project, with construction by Herrick Iron Works, who also performed the prestressing operation under license from the Preload Company, Inc. The tanks are designed with 15-in. thick floor slabs, 9-in. thick prestressed walls, and 9-in. thick concrete roofs, and completely lined with ½-in. welded plate. Before placing the floor slab, angles were set in place with the horizontal leg at floor level and the vertical leg extending down into the space to be concreted. Floor plates, in lengths of 30- to 40-ft and 8-ft wide, then were welded to the angles and tested for tightness.

Next step in the erection was the installation of roof supporting columns and the preshaped wall liners. Wall liner and floor connecting welds then

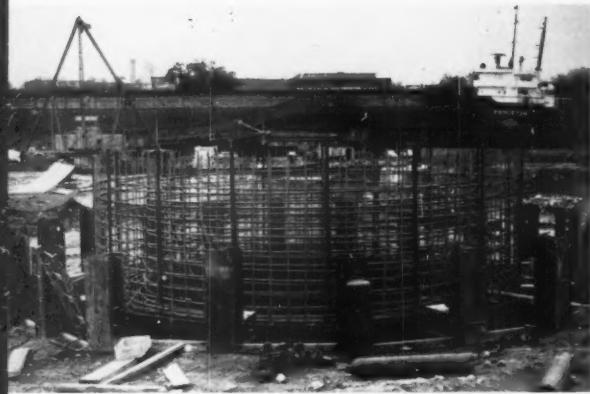
were made, and a backup angle was installed in the outside corner. This construction restrains the horizontal movement of the wall at its base and also allows for wall rotation at the joint without impairing leak resistance. The roof and wall steel served as the inside forms for the concrete. Compressive stress imparted to the tank wall by the prestressing wires ranges from 234 kips per vertical foot at the bottom of the tank to 34.5 kips per vertical foot at the top. A ½-in. thick coat of mortar was applied to protect and bond the prestressing wire. This was given a waterproof coating.



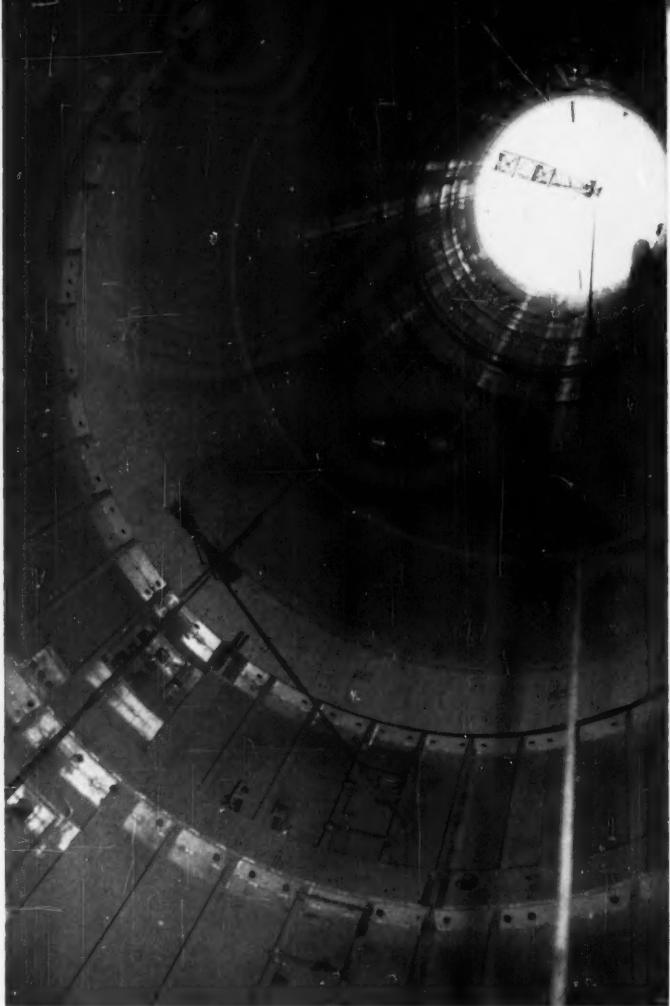
Denver engineers designed pile supported barrel shell base above unstable soil for underground reservoir.



Underground Structures



International Salt Company's new Whiskey Island operation will use underground space for storage and processing of salt. Above is view of cutting shoe and reinforcement for first lift of shaft caisson. At right is view looking up shaft.



Industry Digs In

MINING IS STILL the major U. S. underground industry, and if other industries go underground, many may do so by taking over abandoned mines. A number of mines are already in use as warehouses — and many operating mines are making functional use of their underground space for equipment maintenance, raw material storage, and primary processing. An outstanding example of this is the new salt mining plant of the International Salt Company on Whiskey Island, near downtown Cleveland. Giffels & Rossetti, architects and engineers, is the consultant on the project.

The mine, at a level of 1765-ft below the surface, will be developed in three separate areas in addition to the mining faces. The first area to be developed will be the service and maintenance area. This will house the pumping and ventilation equip-

ment, an electrical substation, mine offices, a lunch room, sanitary facilities, a maintenance bay, warehouse, and the loading facilities for the salt. The maintenance bay will have a 20-ton crane runway, 350-ft long. Repair facilities will be provided for maintaining all the mining machines and equipment, as well as some of the surface plant equipment. The warehouse will be used for both surface plant and mine supplies. The mine area is especially suitable for the storage of machine tools as the hygroscopic nature of the salt makes protective coating unnecessary. In general, all rooms at mine level will be 30-ft wide by 17-ft high.

The preparation area will be developed next. Here crushing and screening equipment will be provided for transforming the salt into marketable grades. Eventually, a storage area will be mined

for stockpiling the various grades for periods of peak demand. A typical example is the salt used for deicing roads in the winter months.

Swedish Industry Underground

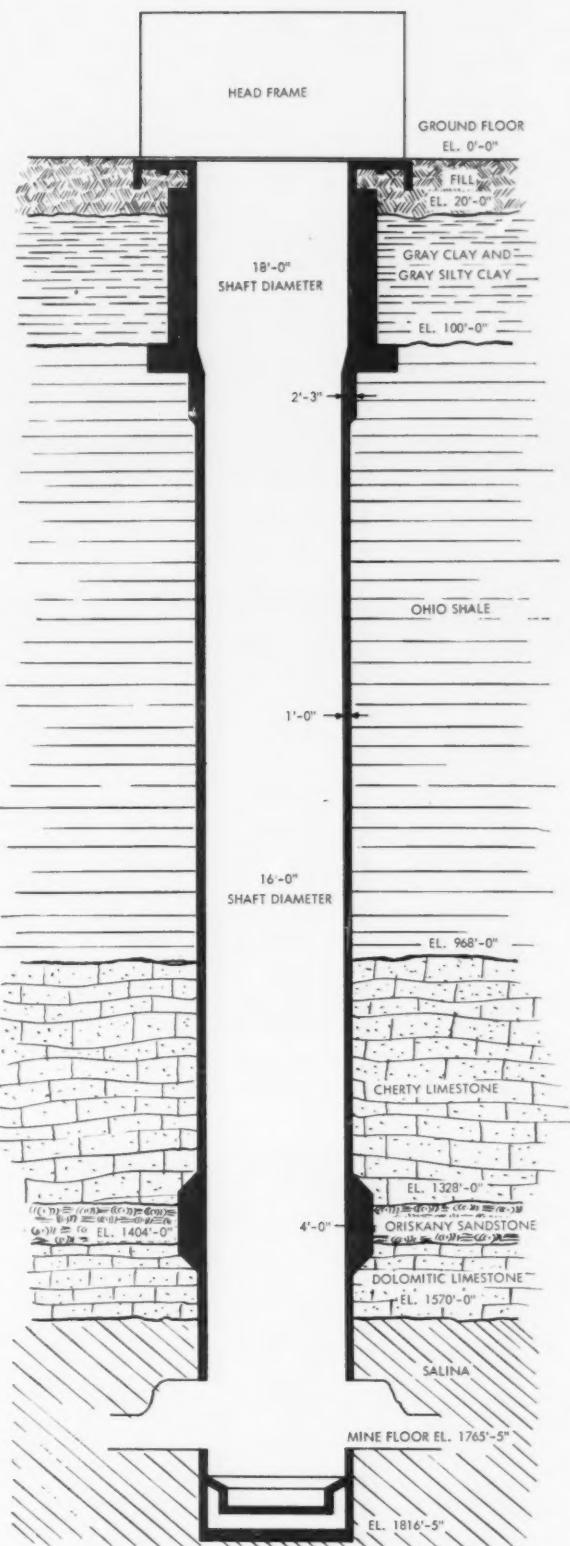
The real story of underground industry, like underground power generation, is being written in Sweden. Manufacturing operations range from the production of small precision parts to complete airplanes. The plants themselves are models of environmental control — clean, light, and airy. Although employees in these plants give evidence of being more health conscious than their fellow workers above ground, they have consistently achieved better records of attendance, turnover, and accident prevention. Much of the credit for this may be attributed to the fact that no expense has been spared to provide excellent working conditions at the underground sites.

Air Conditioning Underground

In the earlier Swedish underground plants, the air conditioning and ventilating systems sometimes created employee discontent. The heat load from lighting and electrically powered machinery was excessive, and it was only partially dissipated through the surrounding earth and rock. Thus, in summer, outside air had to be provided in considerable quantity and at low temperatures to take up the excess heat. The result was drafts, and employees seemed much more conscious of them below ground than they did above.

When the Flygmotor plant, at Trollhattan, was begun, A. F. Rosell, of Alexander & Rosell, reports that considerable psychological research was undertaken to solve this problem. It was decided that plant conditions should be set at 68 F and 50 percent relative humidity and that cooling surfaces within the work areas should be provided so that air temperature in the circulation system could be at a higher level. The final design incorporated cooling coils in the arched concrete ceilings, and an air supply through perforated aluminum panels in all areas where appreciable heat was generated.

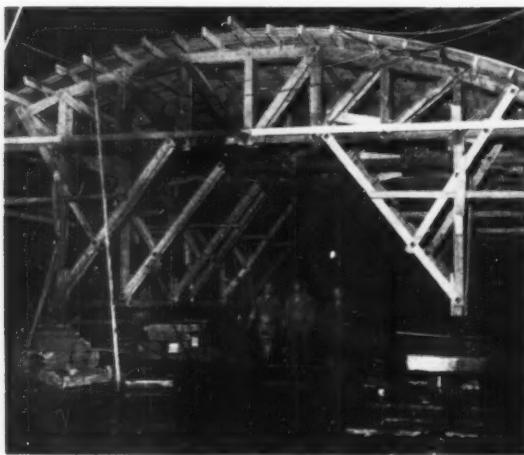
In this plant outside air must be heated throughout the greater part of the year. Thus, a heat pump was specified instead of a boiler. The balance between the waste heat recovered and the heat required for warming outside air in winter is such that only occasional additional electric heating is required. For humidity control, conventional air conditioning also is provided through 11 units located in various parts of the plant. They are fed with hot water from the heat pump system or with brine from a special cooling machine separate from the one used for cooling the ceiling. Control of temperature and humidity is automatic.



Production shaft cross section, Whiskey Island Mine.



Cooling water pipes being tied to reinforcing steel on ceiling forms during Flygmotor plant construction.



Sliding form used in pouring reinforced concrete ceiling. Area between it and rock is used as air duct.



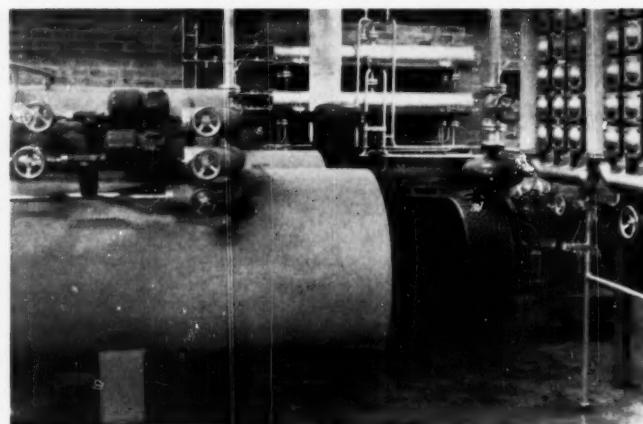
Nonbearing brick wall, with ceiling supported by rock.

To insure flexibility, ceiling cooling coils have been installed in most plant areas whether excessive heat is present or not. Local controls keep circulation at desired levels, and, even in the same room, areas of high heat can receive a higher rate of flow through the cooling coils. Fresh air from an outside supply shaft flows through a pre-heater to a central supply fan. It is delivered to the air conditioning units through concrete ducts located between the rock roof and the concrete ceiling. This ceiling space also is used as a return duct, and return air can be mixed with fresh air.

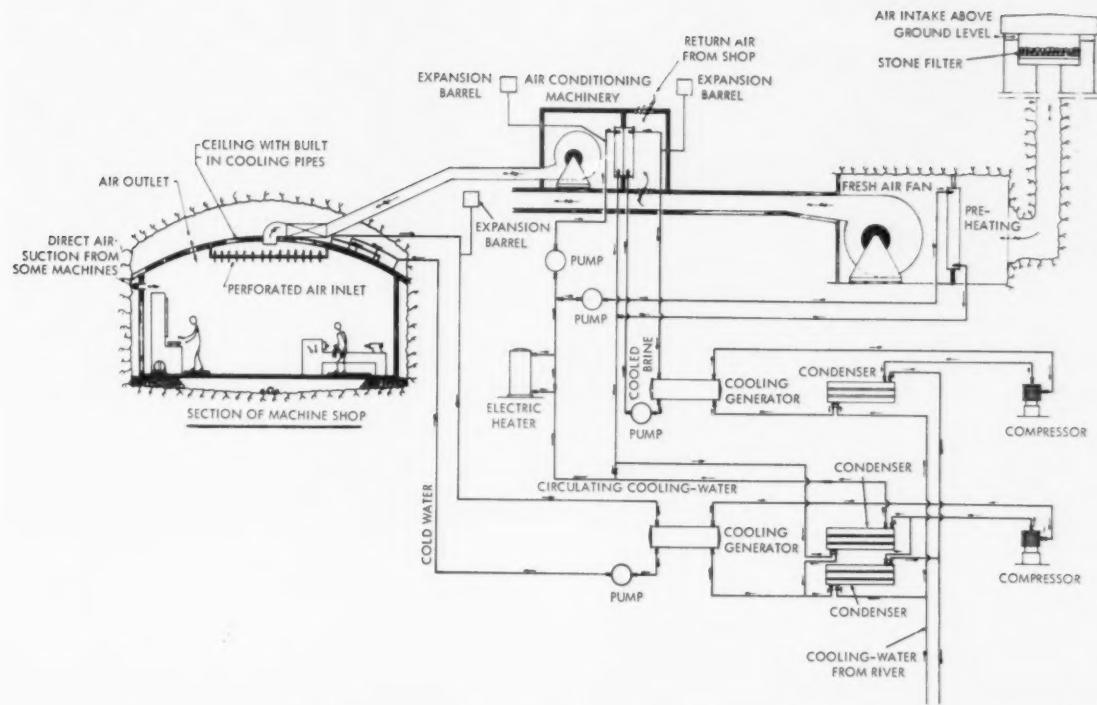
The entire air conditioning system operates with a high degree of automatic control, using both thermostats and hygostats to maintain the temperature-humidity relationship in the desired range. The cost of the heat pump system is about equal to that of a conventional underground system. It has operated according to plan, and caused no trouble even during the summer of 1955 when Sweden had the highest temperatures recorded in 100 years. The Flygmotor plant has been able to operate at temperatures of 65 to 68 F, whereas most other plants are at 71 F or higher. This high (by Swedish standards) temperature is used to prevent complaints about drafts, but it is believed to contribute to the fatigue noted in some plants.

The Wine Cellar At Arstadal

Although Sweden's underground operations can seldom be justified on the basis of cost, there are exceptions. The obvious are the underground hydroelectric plants, but there is another — the \$4 million plant of AB Vin and Spritcentralen (The State Liquor Monopoly of Sweden), designed by Ragnar Wale & Company. Constructed at Arstadal, Stockholm, these rock storage facilities for wines and spirits are said to cost no more than above ground facilities because of low maintenance and



Flygmotor refrigeration system for air conditioning.



Typical Flygmotor plant cross section and schematic of the entire air conditioning and ventilating system.

the naturally uniform temperature needed for storing light wine.

Facilities include eight alcohol cisterns which have been blasted into rock and are built according to the Sentab system — using thin metal tanks encased in concrete. Each of these tanks holds over half a million gallons. In addition, 16 detached steel plate cisterns have been built into one of the wine storage cellars. The wine cellars themselves are almost 50-ft wide by 500-ft long and three stories deep. On the basement floor of one

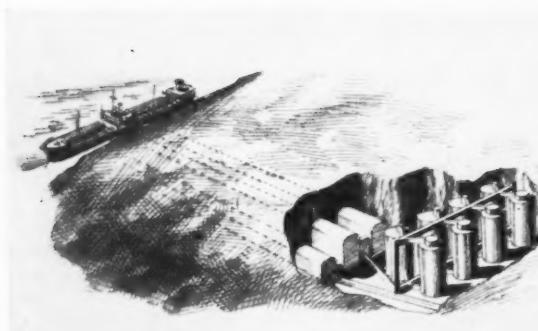
cellar are 181 coated concrete cisterns capable of storing a million gallons of light wine. In the other areas there is space for the storage of 1.8 million gallons of wine in casks and bottles.

Other Swedish Plants

The Saab Aircraft Company is another Swedish firm that has done extensive underground building. One of the outstanding features of its plant is the effort to create an above-ground atmosphere. The entrance is much like that of a normal plant, and



One of the machine shops in the Flygmotor plant at Trollhattan, Sweden. Ceiling is cooled by coil system.



Arstadal wine and alcohol storage system receives both bulk and barreled spirits for underground storage. Bulk storage tanks are built into rock, and second story barrel storage is shown in top photo. Photograph below shows pipelines in tunnel from dock.



the dining room area is brightly lighted, with murals on the walls and a huge aquarium in the entrance hall. Throughout the plant meteorological instruments keep employees informed of above ground weather conditions. Saab has found no difference in its relations with employees who work above ground and those who work below, except for a 4 percent lower turnover rate in the underground plant.

AGA at Lidingo, Sweden, is presently using subterranean workshops for the production of oxygen and fine optical equipment. An apprentice school also makes use of underground space, which, in the event of war, could be converted to production. AB Bofors also operates a large underground plant with five plant tunnels emanating from the entrance and transport tunnel. Each plant tunnel, 100-meters long by 15 wide and 8 high, contains a two-story work area. Fresh air is blown between the rock wall and the inner workshop wall, and return air is evacuated through wiring and piping conduits and between roof and ceiling. □□



AGA plant at Lidingo produces oxygen and fine optical equipment in an underground plant. Photo above shows optics manufacture and below is the mechanical equipment for the ventilating system. Other plant areas now in use for apprentice training can be readily adapted for production if needed.



Bare rock is left exposed in the entrance and transport tunnel of the AB Bofors underground factory.

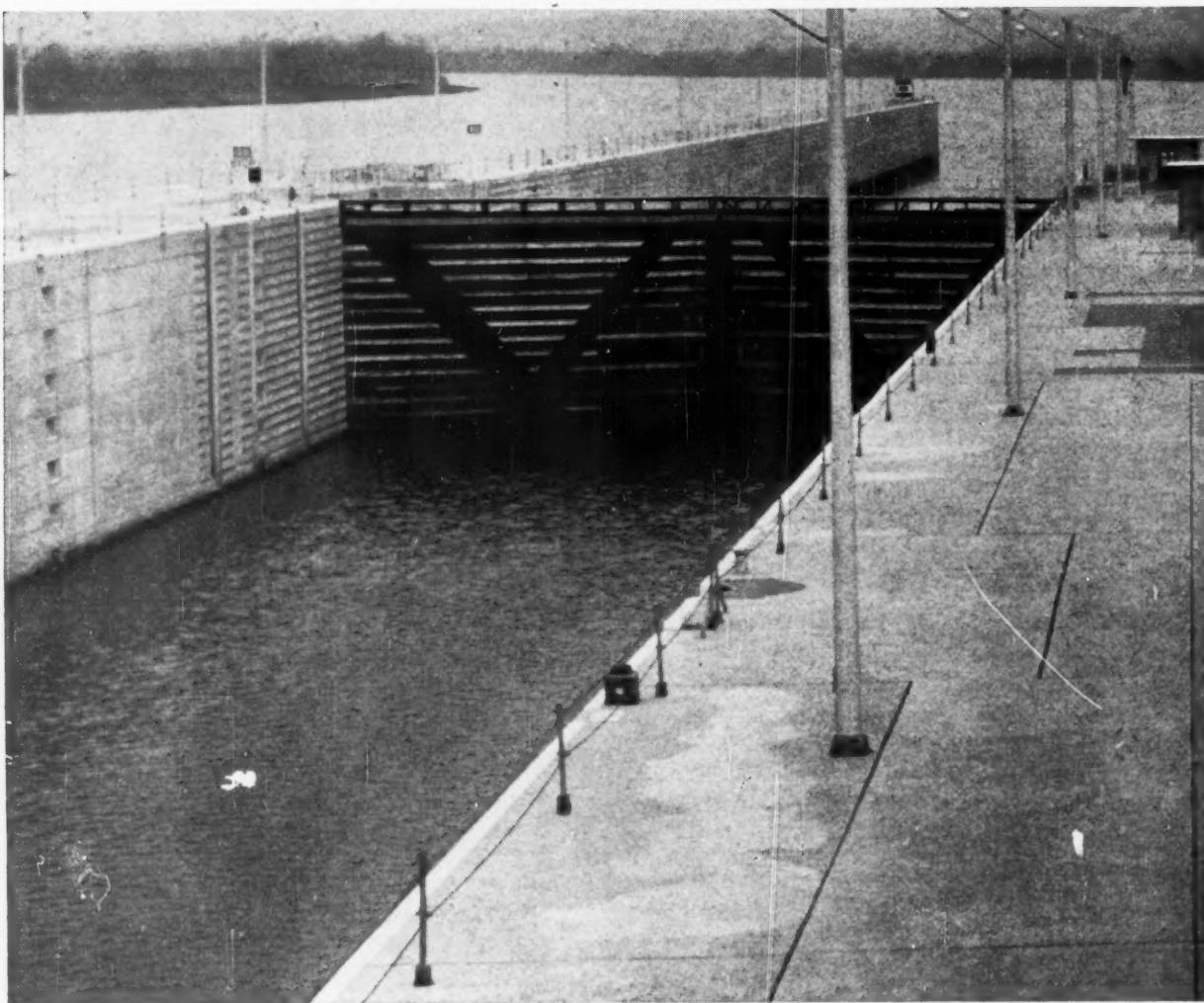


Bofors ventilating system utilizes wiring and piping tunnels for evacuation of return air to the surface.

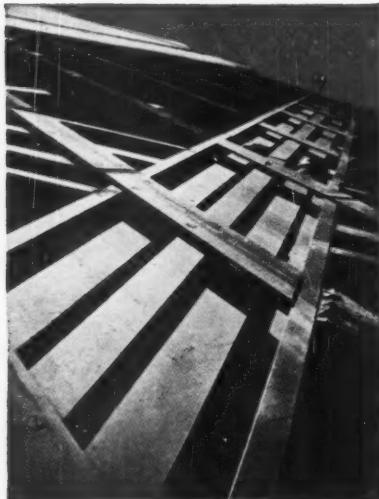


Note fresh air inlets along top of wall and outlet ports in ceiling of the lunchroom at AB Bofors plant.

Gate Fabricator: Nashville Bridge Co., Nashville, Tenn. • Girder Fabricator: McNally Pittsburg Mfg. Co., Pittsburg, Kansas



"T-1" Steel saves 289 tons

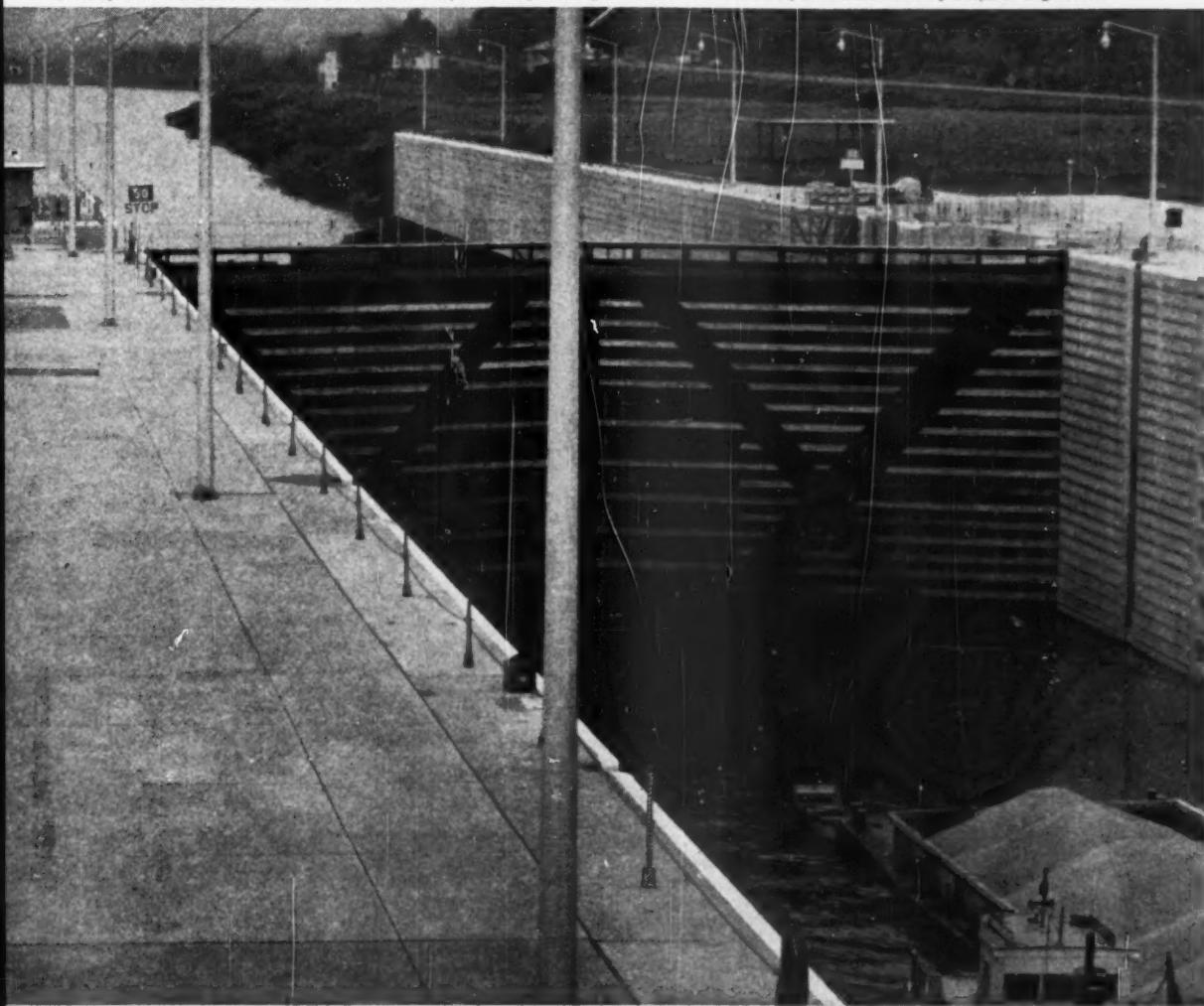


This is a story about how the tremendous strength of USS "T-1" Steel was utilized to save 289 tons of weight in the lock gates at the new Greenup, Kentucky and Markland, Indiana locks and dams on the Ohio River. Each lock gate has five diagonal braces that were designed for USS "T-1" Constructional Alloy Steel. At Greenup, it was estimated that 64 tons of "T-1" Steel did the work of 213 tons of carbon steel in eight gates. At Markland, shown in the picture above, 60 tons of "T-1" Steel were used instead of 200 tons of carbon steel to do the same job.

The diagonal units provide the supports which are absolutely essential to brace the gates. Each diagonal is a flat bar 8 inches wide by 1½ inches thick and about 73 feet long and weighs around 3,200 pounds. Toward the center of the diagonal is a turnbuckle used to adjust tension. By using USS "T-1" Steel, which has a minimum yield strength of 100,000 psi, both the size and weight of the diagonals were greatly reduced while retaining an ample factor of safety.

Lower costs. Reduction in weight because of the use of USS "T-1" Steel meant lower overall material costs, reduced shipping costs by more than one third and decreased handling and erection costs.

Greenup & Markland Lock and Dam Construction: Supervised by Huntington and Louisville District, United States Army Corps of Engineers



of weight in 16 lock gates

USS "T-1" Steel for hoists. Four hoists for the emergency gates at Greenup locks and dam were also built of USS "T-1" Steel by McNally Pittsburg Mfg. Co., Pittsburg, Kansas. The structures are girder sections about 25 feet long and 41 inches deep. Flanges are 20 inches wide by 2½ inches thick. The webs are 36 inches deep by 1¼ inches thick. All were fabricated from "T-1" Steel plates. Each girder weighs about 12,000 pounds.

The new locks and dam on the Ohio River at Greenup, Kentucky were built under supervision of Huntington, W. Va. District, U. S. Army Corps of Engineers. A similar set of locks at Markland, Indiana was built under the Louisville District, U. S. Army Corps of Engineers.

Other uses of USS "T-1" Steel in construction. Wherever great strength is needed with least weight, such as in bridges, TV towers, pressure vessels, and high pressure penstocks, USS "T-1" Steel is unsurpassed because of its high yield strength, high resistance to impact abrasion, and weldability. For complete information write for our "T-1" book. United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

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This mark tells you a
product is made of modern Steel.





Minimize Your Mistakes

ROBERT W. RICHARDS
Howard, Needles, Tammen & Bergendoff

WHEN HE WAS chairman of the board of U. S. Steel, Judge Elbert H. Gary said, **C_E exclusive** "All men who do things make an occasional mistake. The only people who do not make mistakes are people who never do anything . . . the man who profits by his mistakes rises highest on the ladder called 'success'."

Scott B. Lilly, an eminent educator and former chairman of the engineering division, at Swarthmore College, counseled his students and younger faculty colleagues with an adaptation of Judge Gary's logic. "All engineers make mistakes," he would say, "but the difference between a good engineer and a bad engineer is that a good engineer finds most of his own mistakes." To Professor Lilly, a mistake was not evidence of failure but an opportunity to find the truth. His admonitions inspired all with whom he dealt to minimize mistakes.

If an engineering student makes a mistake in solving a problem, the consequence is a lower mark

on the examination and possibly a lower grade for the course. Practicing engineers, however, have much more at stake. Of greatest importance is the possibility of endangering the public. There are, all too frequently, collapses of buildings, bridges, or dams as the result of engineering errors. Unknown to the public are the countless engineering mistakes that are detected and corrected during design or construction. Sometimes these errors are discovered only after some preliminary physical failure or partial collapse. Sometimes construction workers are killed, and even where there is no loss of life, the economic loss resulting from engineering errors is frequently significant and sometimes staggering.

Because most consulting engineers practice as individuals or as partnerships, they are personally liable when they err. Many engineers and their firms have sought to protect themselves against suit for errors and omissions through professional

liability insurance. Yet, this insurance does not excuse inferior engineering any more than a fire insurance policy permits arson.

Engineering errors, however, can be of several types and of varying degree. In mathematics, an error is the difference between a calculated, or measured, value and its true, or exact, value. Slide rule error is commonly understood as the difference between a slide rule reading and the absolute value. These are expected. Mistakes, on the other hand, are unintentional, unknown errors. Blunders are gross mistakes. Suppose a surveyor were using a tape that had been calibrated under known conditions of temperature and tension and found to be 100.003 feet long. If he measures five lengths with that tape and records it as 500 feet, and if conditions of temperature and tension were the same as when the tape had been standardized, he would have a known error of 0.015 feet, which he might or might not consider negligible, depending on the job. On the other hand, had the surveyor incorrectly recorded a measured distance as 46.64 feet instead of 46.46 feet, he would have made a mistake. Had he overlooked an entire tape length or had he chained to the wrong point, he would have committed a blunder.

Mistakes, and especially blunders, have no place in engineering work, yet they must be expected with some frequency. Since economic loss through undetected errors is tremendous, and the hazard to life immeasurable, it becomes a management function within the consulting engineer firm to establish a system of having each man's work checked by a second person, with all corrections of errors back-checked by the first. A system of this type is widely used in some parts of Europe, the checking being done by a different firm of engineers. In Germany, for example, this outside checking is required for certain types of structural design. A special license is required for engineers doing this type of checking of calculations. Their job is not to criticize or change the design, but simply to confirm that it is safe and that all calculations are mathematically correct.

This system of checking and rechecking, even though done within the firm, is expensive. It becomes prohibitively expensive if the checker quibbles over inconsequential differences or matters of opinion, or if the original calculator is so stubborn that he tries to defend his mistakes. But neither can the original designer afford to be careless in the knowledge that whatever he does wrong will be caught and corrected, for the time required to make an independent check depends much on the accuracy and organization of the original calculation or drawing. It is essential, therefore, that the firm's management establish certain fundamental

work habits which, if rigorously followed, will enable an engineer to detect most of his own mistakes and facilitate the checking of his work by another.

Name and Data — Have every employee identify his work with name or initials and date. This should appear on all calculations, drawings, memos, or engineering analyses. This may seem obvious, but too often it is overlooked or neglected. It also is important, even in a small firm, to put "Revision A" or some other identifying designation on the drawings if changes or additions are made. Conversely, superseded work should be marked "Void."

Periodic inspection reports from field engineers can be valueless if not dated. Moreover, the engineer reporting should identify himself with his work so that it can be discussed with him by telephone without long delays.

References — An engineer should give the source of every formula or solution that is not original or obvious. This permits the person checking the work to verify an analysis in the least possible time. When a particular formula has been taken from a text or handbook, the title, author, edition, page number, and case number should be cited. In like manner, engineering reports should not include general statements such as "from statistical analysis, the average compressive strength was found to be . . ." unless a reference is given to permit the checker to satisfy himself that the method of analysis is valid and has been handled correctly. Some engineering reports require special handling to permit rapid reading by some and thorough checking by others. A happy solution is to keep the main report brief, but include full references in appendices. Then, the reader can read, or the checker can check.

Assumptions — The finest solution is worthless if based on incorrect data. All basic data such as physical constants, conversion factors, and mathematical relationships should be checked by the designer if there is the slightest doubt. Every engineering firm should have a good, up-to-date reference library, and all technical employees should learn to use it. This is not a plea for cookbook engineering; it is simply an assertion of a fact — good original thinking and careful calculation cannot compensate for erroneous basic data.

Original Data — Whenever possible, work from first premises. There is less chance of incorporating or compounding errors. A simple example will illustrate this point. Assume a piece of equipment costs \$1250, and it is to be depreciated over a 10-year period on a straight line basis. To find the value of the end of one year, we subtract \$125, and we

have \$1125. To find the value at the end of the second year, we have a choice; we can again subtract \$125, this time from the calculated value at the end of the first year, or we can go back and work on our original value of \$1250, and subtract 20 percent, or \$250. This second choice is preferred, for working from intermediate answers instead of from original data is always dangerous.

Alternate Methods — If time permits, it is good practice to solve a problem one way and to check it by another. For example, a tension spring may be designed on the basis of applied load and allowable shearing stress. Then it may be checked independently by equating external work to absorbed energy. A flexible pavement can be designed by any of several widely accepted methods. Good practice would be to use the CBR method and then to compare the answer with that obtained from the Goldbeck method or some other alternate. The two answers will not be exactly the same because of different means of determining the underlying soil support, but they will be close enough to check.

The ultimate in alternate methods is an analytical solution followed by a test of a full size or scale model. The cost can be justified on many major projects. When the Walnut Lane Bridge, in Philadelphia, was being designed, a full size prestressed concrete girder was tested to destruction to verify the calculations and the quality of product.

Neatness — The correct answer to a problem is not always sufficient. If the solution is to be checked, it must be recorded neatly so that it can be followed readily. Back-of-an-envelope solutions cannot be easily checked and filed for future reference, so they usually do not save time, they waste it. It is a good rule to make all calculations with the expectation that a copy is to be furnished the client. Neat work is not necessarily flawless, but sloppy work is more likely to involve error.

Sequence — Before starting to work on a problem, an engineer should think about the steps he will follow in his approach to the solution. Longer, more complicated problems may call for a written outline of procedure. Calculations resulting from a planned sequence of steps are less likely to involve errors of omission. And again, an orderly analysis can be checked rapidly.

Reasonableness — By reputation, and presumably by training, engineers are disciplined thinkers. They are supposedly logical, methodical, and practical. Sometimes, however, their preoccupation with detail and a too narrow perspective overshadows their common sense. The final practical step should

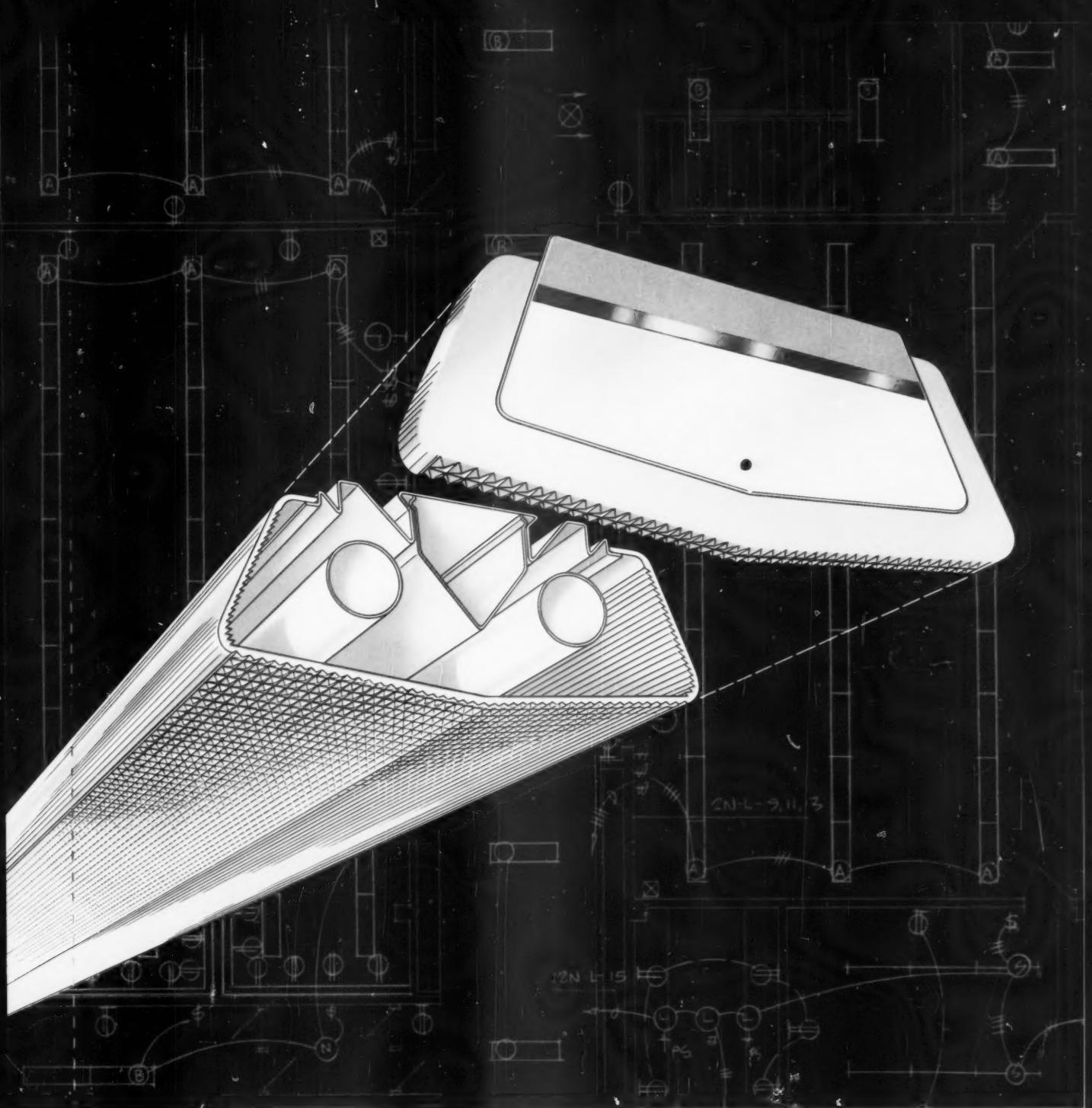
be one of reflection. Does the calculated answer make sense? Is the quantity reasonable? Despite all the old saws about the decimal point, engineers still read their slide rules carefully and then miss on the order of magnitude. They avoid errors and make blunders instead.

Unreasonable answers are often the result of incorrectly converted units. Every design engineer should check the compatibility of units by making a dimensional analysis of the problem as well as a numerical analysis. This precaution will disclose an answer that is, for example, in miles per minute when the desired unit was miles per hour.

Adequate Time — All engineers and designers must be encouraged to take the time to get the right solution. When the project engineer or the department manager is pressed for time on a project, his impatience can cause errors by subordinates.

Retain a Copy — Whenever economically possible, retain a copy of your analysis. It will help you to discuss your work by phone or by mail. It is an excellent guide for future solutions to similar problems, and it will replace the original if it should be lost. Dr. Samuel Johnson, the 18th century lexicographer, is supposed to have lost the only manuscript of a long novel he had written when a charwoman cleaning his quarters mistook it for trash. Unfortunately, we will never know the results of those hours of work expended by Dr. Johnson. Although losses of such magnitude are unlikely for engineers, there has been an incalculable amount of effort wasted from misplaced calculations, reports, and correspondence. Since the cost of a carbon copy, photocopy, or diazo print is so small, it is usually advisable to duplicate original work before submitting it to a client, or routing it to another department or office. The cost of a copy is a small fraction of the labor cost required to replace the material if lost.

Dr. Charles E. Goshen, a psychiatrist, states that "the engineer's most obvious characteristic is his precision, his meticulousness, his attention to detail and accuracy, or his perfectionism." These characteristics, according to Dr. Goshen, cause conflicts both within the engineer and among his associates. In seeking unattainable perfection, engineers develop "a fear of inaccuracy, a sensitivity to criticism, and a dread of failure." Yet, engineering work demands precision. To achieve the required accuracy without the conflicts, engineers must develop proper work habits such as have been described. Then they are bound to benefit the firm and the profession by reducing the accidents and economic loss caused by engineering errors. □□



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Samuel M. Oberowner Takes a Long and Agonizing Cure

SAMUEL M. OBEROWNER adjusted the heating pad on his left shoulder and shoved the cat off the chair. Oberowner was a man in his early sixties, recently retired, and he resented this nagging pain in his shoulder which had been with him for several months — never much better, never much worse. Retirement had left him with a comfortable income and few financial worries, but he was frustrated by his inability to control this confounded pain. In all likelihood he would have to see a doctor, and get pinched, pummeled, stuck, X-rayed, and medicated. Then, before he or the doctor had any idea whether the treatment had worked, he would receive a bill and would be expected to pay even if uncured.

In his own business, he had been obliged to guarantee his work. Doctors obviously did not. As a matter of fact, as professional men, physicians not only were in a position to charge when they failed to perform, they even charged for their errors in diagnosis. He remembered well his experience some years before, when a persistent languor and depression had driven him to a doctor's office. The diagnosis had been hepatitis, but after several months of treatment, loss of weight, and general deterioration of health and pocketbook, he had gone to another doctor, who had assured him (after exhaustive, painful, and expensive tests) that there was nothing wrong with his liver. He suffered instead from mononucleosis. After several months of treatment, his basic good health had reasserted itself.

His depression was interrupted by a visitor, his old friend, Dr. Russell (Bud) Hawker, the pharmacist.

Bud was an unusual person. After a distinguished university career culminating in a doctor's degree, he was stricken with rheumatic fever, which left him with a weak heart. Consequently, he was advised to abandon any idea of entering private practice. He supplemented his medical degree with a degree in pharmaceutical chemistry and secured a position as production and research supervisor for a major drug manufacturer. Later, he invested his savings in a pharmacy of his own, and he had done fairly well financially, despite his insistence on emphasizing drugs rather than garden tools. His background eminently qualified him for this work. Once he caught and corrected a serious error in a prescription. His reputation spread, and people patronized his prescription department even though he charged more than other druggists.

After pleasantries, Bud noticed Sam's distress. He listened to his friend's complaints, then interrupted him.

"Sam," said Dr. Hawker, "I am an authorized dealer for Phonisan, the big pharmaceutical manufacturers, and I handle a lot of their products. They are strictly legitimate manufacturers. As you probably read in the *Reader's Digest*, they use only graduate MD's as detailmen. Phonisan is among the most progressive manufacturers of drugs in the country. The chairman of the board is one of the most unforgettable characters I ever met. When he was convinced that there was a connection between lung cancer and smoking, he had all of his employees give up tobacco.

"Recently, during their sales meeting, a new line was shown to

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doctors and pharmacists. Included was a new oral drug — that means taken by mouth — particularly effective in the treatment of arthritis cases which in the past responded only to cortisone derivatives that must be injected (Sam winced) into the bloodstream. Their dangerous and unpredictable side effects are well known. The new drug is Pseudophonicin, and the chairman of the board told me himself that he has absolute confidence in his

new product. He has hired one of the leading industrial designers in the country to design the package. A top technical writer is working on the instruction manuals and the publication of the test results. The treatment is rather expensive at the moment — they have to pay for all the research. The capsules retail at \$5.00 each, and the dosage is a capsule a day for 30 days."

Oberowner showed interest through his pain. "Bud, he said,

"you are not just a druggist, you are a medical doctor, licensed and registered. You have as much right to prescribe for me as any doctor in private practice. Not only that, you are a lot smarter than most."

"You are right, Sam," Bud agreed. "I am licensed to practice medicine, and it is true that I know more about you and your condition than any stranger you could call in. And I have confidence in the Phonisan firm. They make good products. Their research man told me they know more about arthritis than anybody in the country.

"I don't usually prescribe, even though the law lets me, because private practitioners don't like competition from a druggist, but you are a friend, so I'll make an exception. And I can save you a lot on the drugs. Phonisan is one of the few firms that seems to understand that the druggist has to make a living, too. Their products have an excellent markup; I can let you have those \$5.00 capsules for only \$2.00 each."

"But, Bud," Sam objected, holding up his good right arm for silence, "I don't like being a guinea pig; I would rather use something that's been tested."

"Tested? Why this drug has been thoroughly tested. It was given to the inmates of a large home for senior citizens, and it proved 99 percent effective among males under 70. You can be absolutely sure about this one. Testing is part of the product at Phonisan. Let me have your check, and I will have my man deliver the pills right away. You can start treatment immediately. Believe me, you are as good as cured now."

Sam hesitated, then hope won the day. An investment of \$60 was less than X-rays alone would cost him if he went to a medical practitioner.

After two weeks of treatment, Sam noticed considerable relief. Soon he was able to sleep undisturbed by pain, and before all the pills were used up, he called his



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Regardless of upstream variance, this sensitive G-A valve always delivers water at the same predetermined pressure.

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Write for Bulletin W-3A



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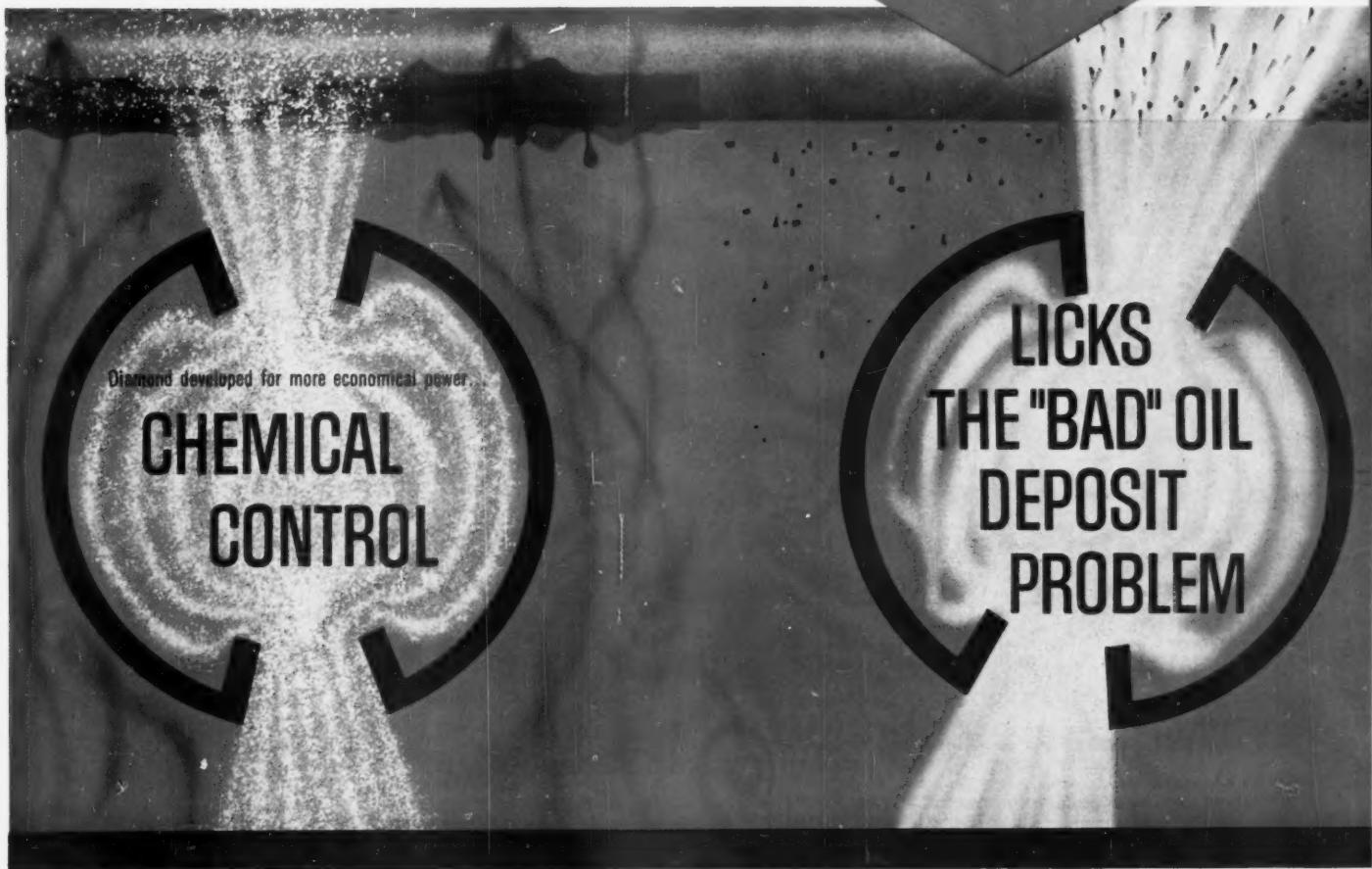
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friend Bud to report that the miracle was complete — the pain was gone; the heating pad was banished to the closet; life was worth living again.

About a week passed. Sam awoke one morning after a restful night, and went to the bathroom to shave. He looked at himself in the mirror and scowled. There was something about his complexion. It could be the light, he decided, but his normally tanned skin now

seemed deathly pale. But, no! It was a ghastly powder blue.

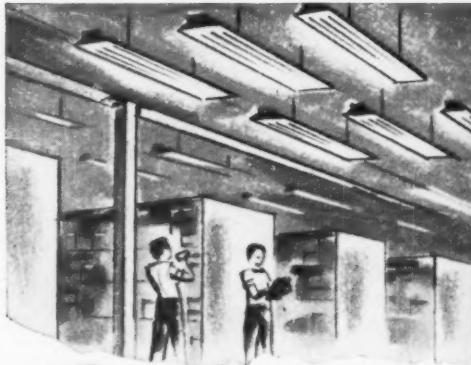
Sam put down his razor and went for the telephone. Bud was shocked to hear of the development. He hurried over to express his regret, and he called Phonisan from Sam's house. After a long call, he reported that Phonisan would send their chief research man by plane. He arrived the next day, and began a series of tests. Sam was pinched, pummeled, stuck, X-

rayed, and medicated. Nothing helped. His skin tone changed from blue to purple, then to bright magenta, and finally back again to the more pleasant powder blue. When he could forget his complexion, he was somewhat relieved to realize that at least his shoulder pain had not returned. For that he was thankful, but his temper was terrible. He actually threw a chair at Bud when he inadvertently suggested that Sam should "try not to feel so blue."

After giving both Dr. Hawker and Phonisan proper notice, Sam proceeded to sue. Months later, the court decided that Dr. Hawker had acted legally and properly, since he was licensed to practice medicine and he had not misrepresented the product. The unfortunate change in Sam Oberowner's skin color was the result of a rare allergy, which could only have been detected after exhaustive tests involving pinching, pummeling, sticking, X-raying, and medication. The judge of the appeals court, in handing down his decision, sympathized with Sam, and explained that he might just barely have a case against Dr. Hawker if he sued him as a physician and claimed malpractice, but he did not suggest that he pursue that course since Hawker would claim that he had acted only as a pharmacist, not as a medical doctor.

Sam became a recluse. He sat in a darkened room, brooding. Then, one morning, he looked again into the shaving mirror and found the color of his skin changing . . . A few weeks later, he looked pale, but almost normal. About the same time, the pain in his shoulder came back.

Sam Oberowner is now in his second month of treatment under Dr. Edwin Aston, the eminent internist. After a series of injections, his pain is slowly disappearing. The lawyer's fees have been paid, and apart from an occasional anxious glance at the mirror, Sam is his old self again. □



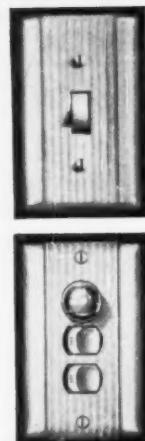
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Available in either full port or reduced port; rectangular, round, diamond and V-ports; also venturi, multiport and steam-jacketed models.

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X-TRU-COAT Plastic-Coated Line Pipe (Republic coats it at the pipe mill) is available in 1.050" through 8.625" O.D. You can also have the coating on Republic Light Wall—in 1" through 4" nominal—for low pressure gathering and distribution systems.

The complete package includes Republic X-TRU-COAT, X-TRU-TAPE Joint Wrap, and X-TRU-PRIMER. For information or quotations, call your nearest Republic representative or mail the coupon. X-TRU-COAT is produced under the Dekoron® Process.



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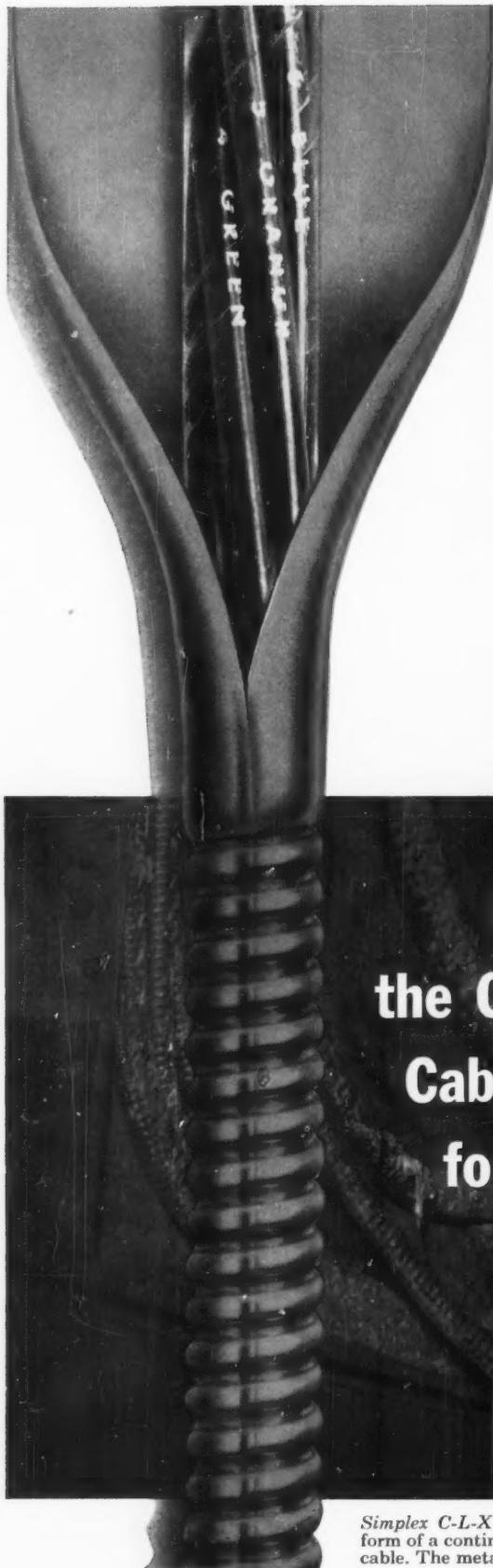
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The New Projects

Plastic Design for Tire Plant

The largest building in this country incorporating plastic design theories was recently completed for the Gates Rubber Company, near Nashville, Tennessee. The building, a 15 acre plant for the manufacture of tires, makes use of the ductile properties of steel, providing the same margin of safety afforded in the elastic design of simple beams. The project engineer, Rust Engineering Company, of Pittsburgh, reported a saving of 140 tons of structural steel through the use of the plastic design theory.

Big Cooler

The largest comfort air conditioning system west of the Mississippi is in operation at the Canoga Park, California, plant of Thompson Ramo Woolridge, Inc. The seven-building complex, spread over 90 acres in the San Fernando Valley, is completely open to the sun, and summer temperatures often reach 115 F.

Instead of the usual cooling towers used in large air conditioning systems, the project architect-engineer, A. C. Martin, of Los Angeles, used two large spray ponds for heat rejection. The two ponds, each 100 ft by 200 ft, have a combined capacity of 330,000 gallons. They were constructed in the center mall of the project to be ornamental as well as functional.

Built around a Recold fan-coil distribution system, a 5000-ton capacity central plant furnishes air



conditioning on schedule and in any volume to any section of the sprawling plant. Engineering the project was simplified to a certain extent by the nearly constant humidity in the area; the extreme heat was the only problem. No attempt was made to control the humidity.

A New Number Five

The British Minister of Transport has announced approval of the proposed Severn Bridge, which, when it is completed, will rank as the fifth longest bridge in the world. The 3240-ft span will cross the River Severn between England and Wales.

The bridge itself will cost an estimated \$30 million, with another \$15 million for approaches and access roads. The road level on the new Severn span will be 130 feet above the ordinary high tide, and clearance for navigation at the center will be 120 feet. The British firm of Mott, Hay and Anderson was consulting engineer on the project, in association with Freeman, Fox and Partners.

Main span of the steel suspension bridge will be only 60 feet shorter than the almost-completed Forth Road Bridge, which will be the world's



The huge Thompson Ramo Woolridge plant in Southern California is built around ornamental spray ponds.

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King Manometers are used throughout industry for measuring pressure, vacuum, differential pressure, and pressure-related phenomena. They operate as a liquid-filled U-tube (the *basic reference standard* for pressure measurement) -- have no mechanical moving parts. Their readings depend *solely* on the force of gravity, the specific gravity of the indicating liquid, and the pressures applied. Thus, they are unfailingly accurate -- and they permit exact duplication of operating conditions.

In addition, King Manometers are inexpensive, easy to install, cost nothing to operate, and require practically no maintenance.

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Single cleanout (shown at right); double cleanout; with 3-valve manifold; inverted.



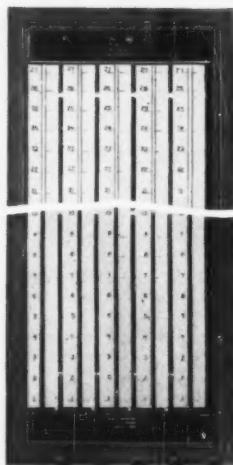
Well-Type Manometers

Low-well (shown at left); raised-well; adjustable-well; barometric; instrument test (8-scale); flowmeter.



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With individual wells in fixed position; with common wells, fixed or adjustable; Photo-Manometers.



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- Full line of accessories.

MANOMETER CATALOG 2008 explains basic principles; simplifies manometer selection; shows complete line of manometers, accessories and indicating liquids. Write for it.



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fourth largest. The three largest bridges are all in the U. S.: the Golden Gate Bridge, the George Washington Bridge, and the Mackinac Bridge.

Power Afloat for National Defense

The New York consulting firm of Burns and Roe, Inc. has been awarded the contract for maintenance of one of the world's largest floating power stations, the ship YEP-10. The station is now providing power for this country's first Ballistic Missile Early Warning System installation.

New Bethlehem Headquarters on West Coast

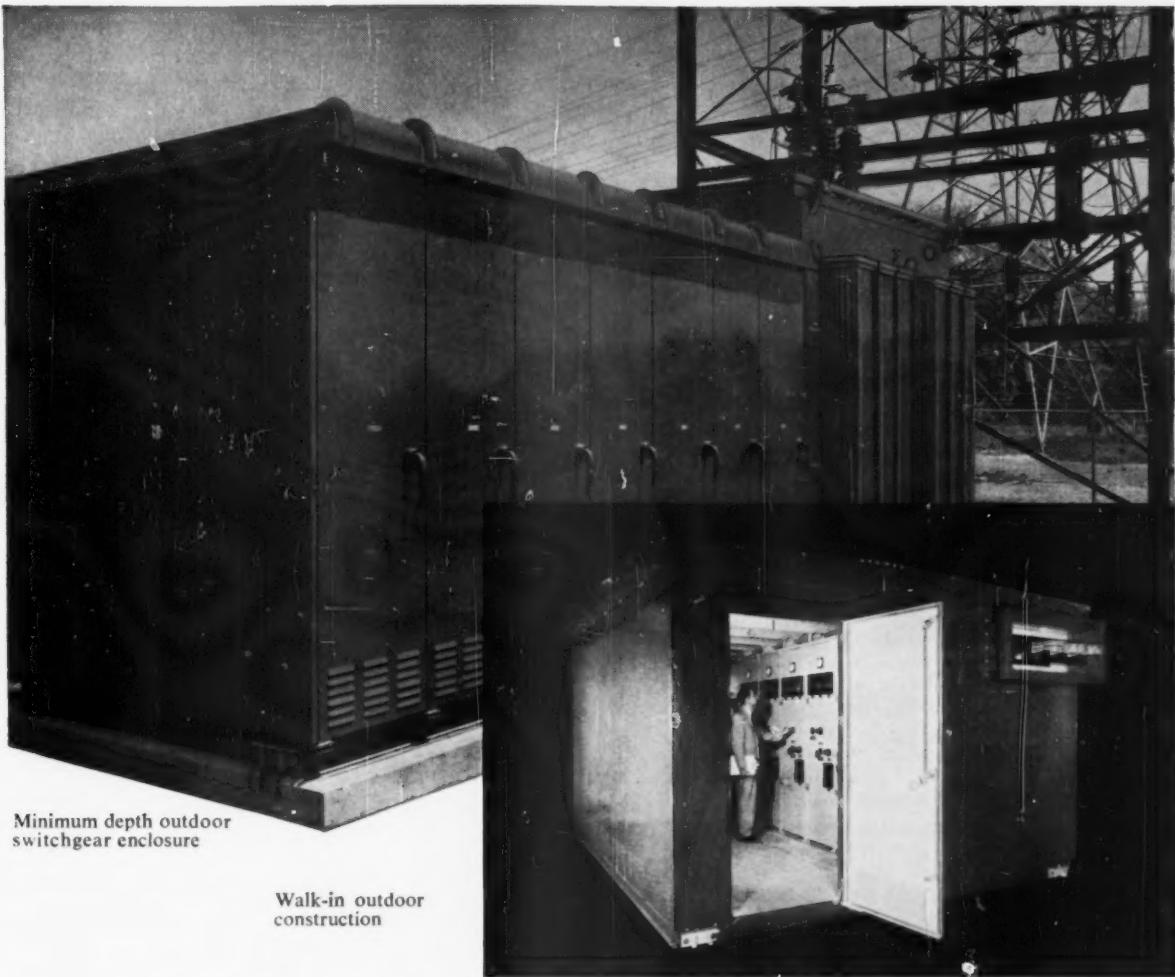
The Bethlehem Steel Company has moved into its recently completed West Coast offices, in San Francisco. The 15 story office tower was designed by Welton Becket and Associates, of Los Angeles.



Bethlehem Steel's new headquarters appears to float between the black and white sheathing on the columns.

The client's product was used throughout as much as possible. The frame, exterior columns, and interior and exterior trim are all steel.

An unusual architectural feature of the building is the system of exterior columns, between which the building is suspended. The free standing columns, together with the location of the utilities in a compact central core, provide extreme flexibility in the structure. The exterior columns are sheathed in a striking combination of marble and



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Walk-in outdoor construction

All-new switchgear makes I-T-E primary unit substation better buy than ever

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And now! I-T-E primary unit substations come with completely new HK switchgear as standard equipment. You get all the advantages of today's most advanced switchgear in outdoor equipment: new compactness, stored energy closing, new ease of access, and new safety

for personnel. It's available in minimum depth outdoor enclosures for areas where space is limited, or outdoor walk-in construction for easy maintenance in bad weather. All doors and joints are completely gasketed. All parts are treated for rust resistance and painted prior to assembly.

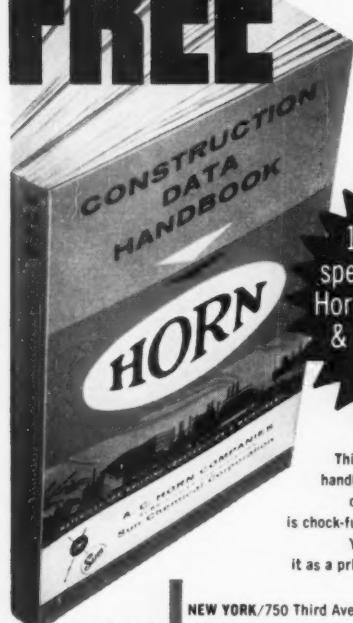
I-T-E primary unit substations are available in all standard kva ratings and secondary voltages to 13.8 kv. Write for complete information. I-T-E Circuit Breaker Company, Dept. SW, 1900 Hamilton St., Phila. 30, Pa.



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Federal 3-3177
Thomas P. Ryan, mgr.



granite. By setting the 13 story tower section on one side of the 2 story base, the west side was left free of columns for location of an auditorium. In addition, the open deck space provides a buffer zone so that another building cannot block out the tower's west windows.

Kaiser Center

The Kaiser industrial organization has housed its entire executive staff in one building — the 28 story office tower that dominates the new Kaiser Center, in Oakland, California. The huge office building,



A huge curved tower dominates the new Kaiser Center.

the largest one west of Chicago, presently accommodates some 2500 office workers, with room for an additional 1500 as Kaiser expands.

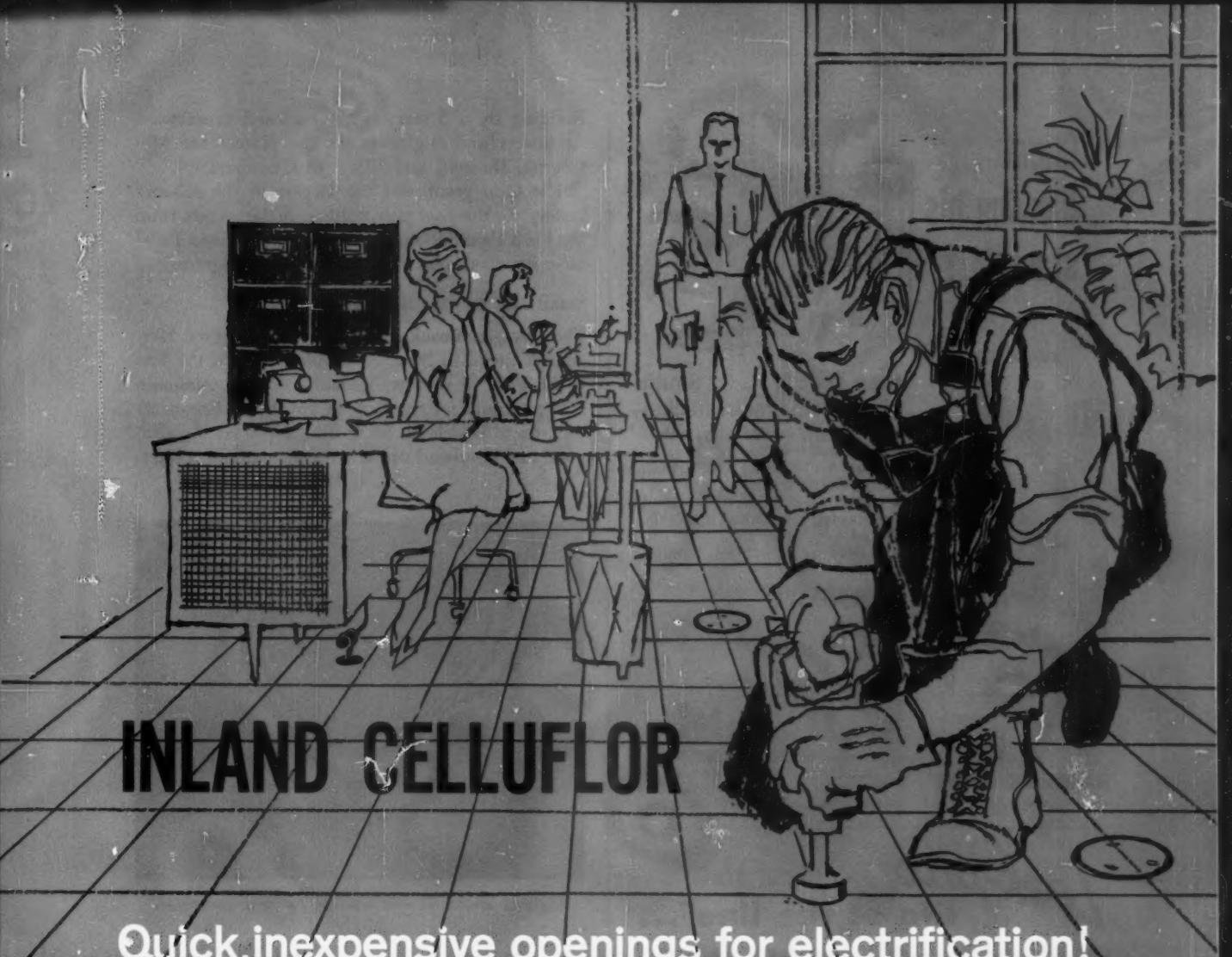
About 80 percent of the structure is built of products and materials manufactured or processed by Kaiser-affiliated industries, including concrete, plaster, aluminum, and steel. Extending 420 feet along Lake Merritt in a gentle curve, the building dominates the eastern skyline of the San Francisco Bay area.

In addition to office space, the Kaiser Center provides room for department stores, specialty shops, service companies, and parking ramps. The entire project was engineered by Welton Becket and Associates, of Los Angeles.

The New Face of Case

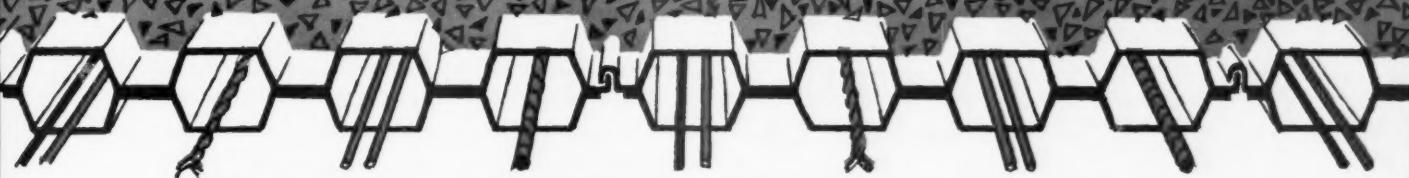
Case Institute of Technology, in Cleveland, has received a gift of \$1,637,000 from the Olin Foundation, Inc. for construction of a new research laboratory. The new facilities, to be known as the Olin Laboratory of Materials Sciences, will complete the "new face of Case," the university's current expansion program.

The laboratory will be an 8 story building, taller than any other on the campus. It will be faced in limestone, and connected to the present Metallurgy



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Quick, inexpensive openings for electrification!



*... whenever you want them, wherever
you want them — with Celluflor*

The typical office interior today is streamlined to the nth degree. Big open work areas — a bare minimum of walls.

Where, then do you put the miles upon miles of wire a modern office building needs now — and the additional miles it's sure to need tomorrow? More and more architects are reaching this logical conclusion: *In Celluflor.*

Since Celluflor provides wiring raceways 6" o.c. under every square foot of floor area, no worker need ever be more than inches away from electrical, telephone, and dictation service outlets. Whenever a tenant needs a new connection, he has an electrician drill through the floor and pull up the wires — anywhere in the room! Circuits can be changed — new service outlets installed or relocated — without costly alterations.

Many buildings with a future use this floor with a future — including Union Carbide office building, New York City, and Kaiser Center office building, Oakland, California.

There are other advantages of Celluflor — savings of steel, footings, construction time, and overhead. See Sweet's — or write for Catalog 270.



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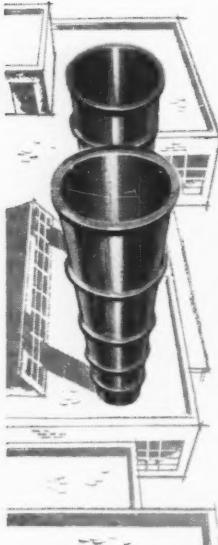
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blowing his
stack...?**



**then specify A. O. Smith
glass-lined smokestacks—**

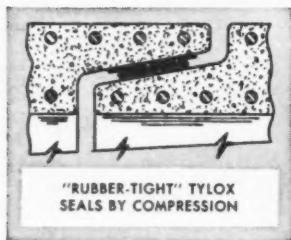
Build client satisfaction with a smokestack that:

- Lasts 3 to 5 times longer than unlined steel stacks
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Heavy duty, acid-resistant, flexible TYLOX Gaskets are made for large bore tongue and groove pipe. They are quickly "snapped on" to the pipe, and the pipe quickly coupled into the line. TYLOX reduces construction costs by speeding pipe coupling, and forms a compression seal that stays tight for the life of the pipe. TYLOX reduces treatment plant costs by preventing infiltration. REXON No. 2 PIPE COATING is a synthetic hard rubber which vulcanizes to pipe by catalytic action, not by evaporation which causes pin-holes. REXON No. 2 protects concrete pipe from deterioration by hydrogen sulphide gas, oils, greases and solvents. WRITE FOR MORE DETAILS.

HAMILTON KENT MANUFACTURING CO.

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Building by a 5 story, glass enclosed breezeway. Architects and engineers for the project are McGeorge, Hargett, and Hoag, of Cleveland.

The Olin grant was the largest in the school's history. In the past year, million dollar grants from the Ford Foundation and the Leonard Hanna Fund have financed most of the expansion program.

Small Housing for Big Generator

The new Merrimack generating station, on the Merrimack River, in Bow, New Hampshire, is the first to be built in northern climates with a minimum size enclosure for the turbine generator. Engineers Jackson & Moreland, of Boston, replaced the conventional overhead crane with an outdoor gantry,



Lighted section is sole housing for new generator.

enclosing only the generator and saving over \$350,000. The decision to use the minimum housing came after weighing the tremendous savings against the possibility that once-a-year servicing of the generator would be necessary during the winter.

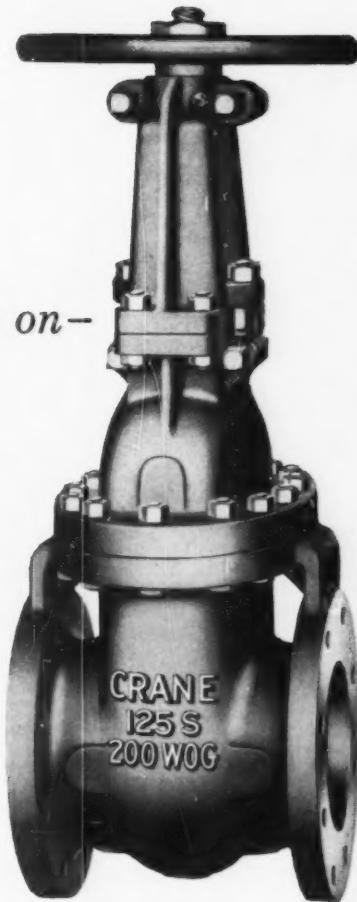
The housing itself is constructed of lightweight, translucent wall panels manufactured by Kawall Corporation of Manchester, New Hampshire. The entire structure was prefabricated at the factory, and erected in 72-sq ft sections.

The present plant is the first of four to be built at the Merrimack site for the Public Service Company of New Hampshire.

Expansion at Brookhaven

Malan Construction Corp., of New York, has been awarded the contract for the construction of the new \$860,000 East Experimental Building at Brookhaven National Laboratory on Long Island. The new building will be tied to the existing Magnetic Enclosure Target Building, and will house mechanical controls and measuring devices, including pipe-

The valves most plants rely on—



No. 465½,
125-pound iron body
gate, bronze trimmed.
Sizes 2" to 48".

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On general utility services . . . water mains and distribution lines . . . low-pressure steam and hot water . . . air and gas . . . more plants rely on Crane No. 465½ iron body bronze trimmed gates than on any other valve in this class.

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To enable you to standardize on these economical, efficient valves, Crane builds them in a full range of sizes. Popular sizes are available from local stocks of your Crane Distributor.



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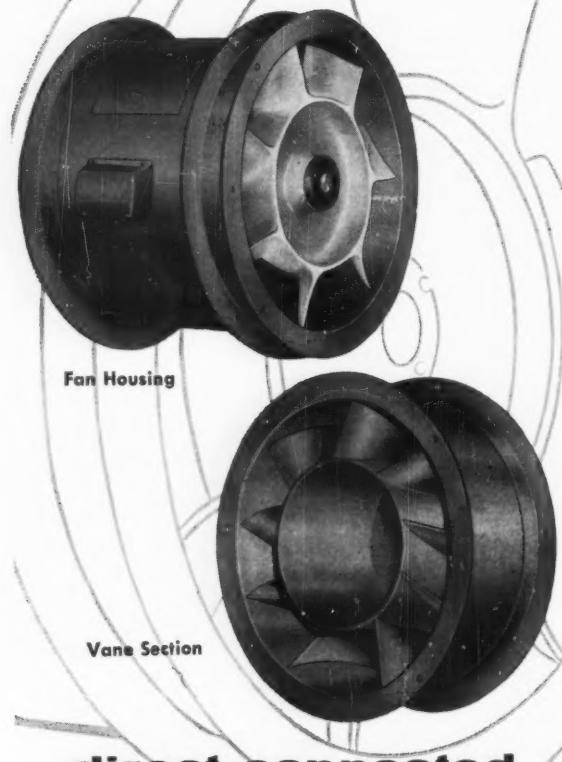
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Write for Bulletin 475

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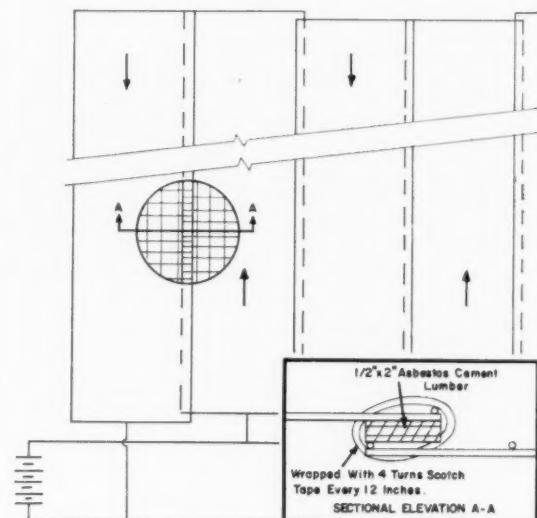
PIQUA, OHIO

lines for minus 423 F liquid hydrogen. Project consultant is Stone & Webster, of Boston.

Radiant Heating Through Reinforcing

One of the first practical designs for using wire reinforcing fabric for electrical radiant heating has been incorporated into a new service center and warehouse for the Northeastern States Power Company, in Minot, in North Dakota. This installation will test the further commercial possibility of combined heating and reinforcing elements.

Major problem in the design was the fact that the fabric had to be overlapped for effective use in the concrete slab, but had to be electrically



North Dakota power company used this pattern for an experimental combination heating-reinforcing element.

separated to maintain proper current flow. The problem was solved by placing a 1/2-in. by 2-in. strip of cement asbestos lumber between the overlapping wires, and binding them temporarily with wrapped electrical tape.

With the fragile strips holding it together, the reinforcing could not be placed in the cement in the usual way. Instead, a 2-in. slab was poured and allowed to harden. Then the wire fabric was laid in place on top of it, and another 4 inches of concrete poured over it.

Six dry-type transformers will be used to power the radiant network in the 6500-sq ft floor. Current flow in the fabric is calculated to be 500-600 amps, at a potential of about 20 volts. This is designed to emit 20 watts per square foot, with a resultant floor temperature of 80 F. Consulting electrical engineer on the project was Kenneth O. Tompt, of Fargo, North Dakota. □



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As the reputation for quality and dependability of Thermal air conditioning and ventilating equipment becomes known, more and more banks, as well as all other types of buildings, are using Thermal.

This is equipment with quality to give satisfaction and long life. Design features combine ready accessibility of internal components with rugged construction.

For further details on air conditioning and ventilating equipment you can specify with confidence, write for complete catalog and names of nationally known concerns using Thermal. The Thermal line includes central and multizone conditioners, sprayed coil units, heating and ventilating units, heating and cooling coils, and air-cooled condensers.

Here are some of the banks using Thermal equipment:

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Dade National Bank, Miami, Florida
Florida National Bank at Brent, Pensacola, Fla.
First Federal Savings & Loan Bldg., Hattiesburg, Miss.
East Central Branch, Bank of New Mexico, Albuquerque, New Mexico
Bank of Broken Arrow, Broken Arrow, Oklahoma
First National Bank, Muskogee, Oklahoma
First National Bank, Abilene, Texas
First Savings & Loan Bldg., Corpus Christi, Texas
Austin Savings & Loan Co., Austin, Texas

North Austin State Bank, Austin, Texas
Security State Bank, Beaumont, Texas
American National Bank, Beaumont, Texas
Farm-Home Savings & Loan Bldg., Ft. Worth, Texas
Raymondville State Bank, Raymondville, Texas
First National Bank, Rockport, Texas
Bellaire State Bank, Bellaire, Texas
Lockhart Savings & Loan Bldg., Lockhart, Texas
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THE FAIRVIEW IV

Day-Brite's newest design achievement delivers today's higher recommended footcandle levels while retaining the trim, sleek look so sought-after in modern architectural planning. Its clean, crisp styling fits neatly into school, store, office or institutional applications.

A companion fixture to the popular FAIRVIEW II, the FAIRVIEW IV is especially designed for two, three, or four lamps parallel. 8-foot units also available in tandem Rapid-Start or 8-foot Slimline lamps. Can be suspended or surface mounted.

X-5 prismatic CLEARTEX® enclosure controls brightness... translucent sides wipe out harsh ceiling contrasts. Both enclosure and channel are of one-piece construction for simplified installation and servicing.

For more information on the new FAIRVIEW IV, contact your Day-Brite representative listed in the Yellow Pages or write: Day-Brite Lighting, Inc., 6260 N. Broadway, St. Louis 15, Mo. and Santa Clara, Calif. In Canada: Amalgamated Electric Corp., Ltd., Toronto 6, Ont.



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FAIRVIEW IV
2, 3, or 4 lamps parallel. 14" wide, 4 $\frac{1}{2}$ " deep.



FAIRVIEW II
10" wide, 4 $\frac{1}{2}$ " deep.

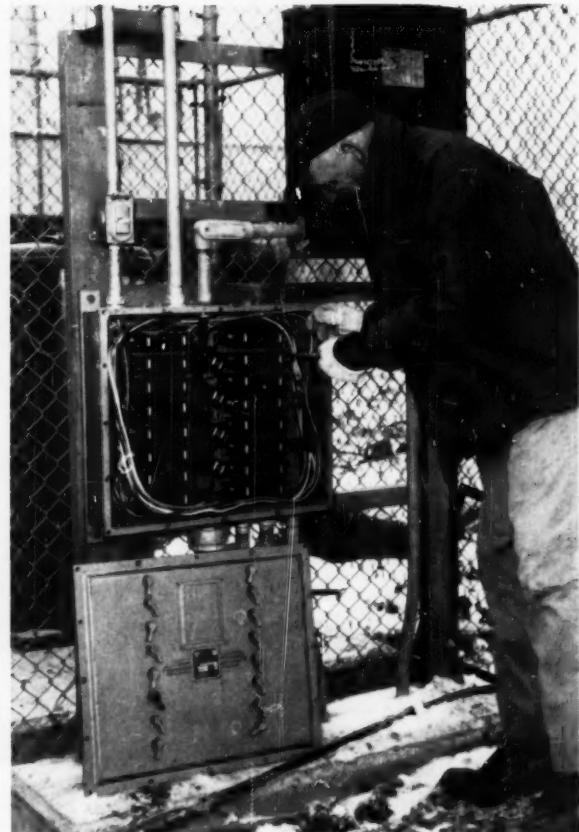


OPENS EASILY



Another new development using

B.F.Goodrich Chemical *raw materials*



New THW wire insulated with Geon is used in sizes up to 3/0 AWG at this new Sohio plant. Wire is made by the Paranite Wire and Cable Division of the Essex Wire Corporation, Marion, Indiana. B.F.Goodrich Chemical Company supplies the Geon vinyl.

"We welcome the higher factor of safety" ... of new THW wire insulated with GEON vinyl

These pictures show new wiring going into the Sohio Chemical plant at Lima, Ohio. Here's what the contractor, W. W. Clark Corporation of Cleveland has to say about it:

"In a chemical plant or refinery, electrical wiring often has to go near processing equipment that operates at high temperatures. We try to keep it at least a foot away, but sometimes have to go as close as 6". We welcome the higher factor of safety this new THW wire gives us."

Now you can add new heat resistance to the proved properties of insulation of Geon vinyl. Geon is tough, weatherproof and keeps its exceptional properties with age. It also resists oils, greases and chemicals.

For information about Geon wire and cable covering, or other ways that Geon improves products or opens new markets, write Dept. GI-6 B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15,

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MARJORIE ODEN
Eastern Editor

The Committee On Engineering Laws

CORPORATE PRACTICE of engineering is permitted in the revision of the Model Law for registration of engineers, as adopted by the National Council of State Boards of Engineering Examiners, in Oregon, last August. As a result, the Consulting Engineers Council is leveling its guns at the Committee on Engineering Laws, an organization formed for the encouragement of corporate practice. Staring down gun barrels, however, is nothing new to CEL. As its executive director, F. E. Lyford, puts it, "Other people have disagreed with us often, but we have been in business for a long time."

Action No Surprise

Lyford does not understand why the Council was surprised at the action of the National Council of State Boards of Engineering Examiners. "One look at the delegates to the meeting should have indicated the outcome for anyone. How many NCSBEE members were going to vote against the corporate practice clause when corporate practice is legal in their own states? After all, corporate practice now is permitted in 44 states.

"As to anyone thinking the clause was railroaded — a reading of the

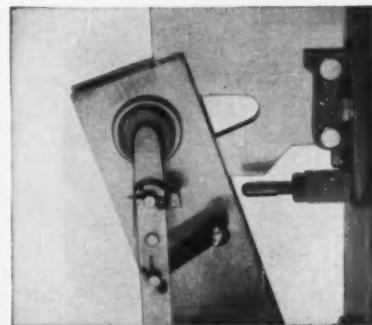
Field Notes

rules would have made it clear that no extended debate could be held at the NCSBEE meeting. The organization rules clearly limit debate, with speakers being given a maximum of three minutes. Also, amendments cannot be offered from the floor. A proposal must be either accepted or rejected as it is presented. Going to that meeting without knowing about the debate limitations in advance was like going out onto a football field without knowing the rules."

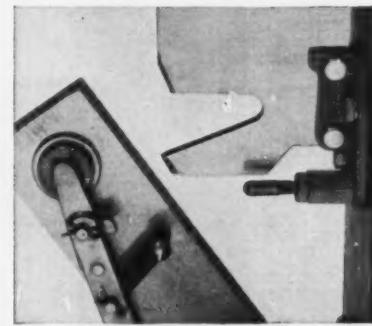
Private Practice A Small Segment

There are other reasons why the NCSBEE action is not surprising: ¶ An article, by William Britton Stitt, attorney for CEL, quoted a 1929 statement by T. Keith Legare, recently retired NCSBEE executive secretary. Legare classed consulting engineers with those forms of life rapidly becoming extinct: "With the development of large engineering companies and corporations, and the growth of large state, municipal, public utility, railroad, and other engineering organizations, the practice of engineering is becoming less and less a field for the individual practitioner . . . Unlike such professional service, for example, as that of the physician, which is and probably always will be a service of an indi-

OPENS EASILY



EVEN AFTER 10 YEARS



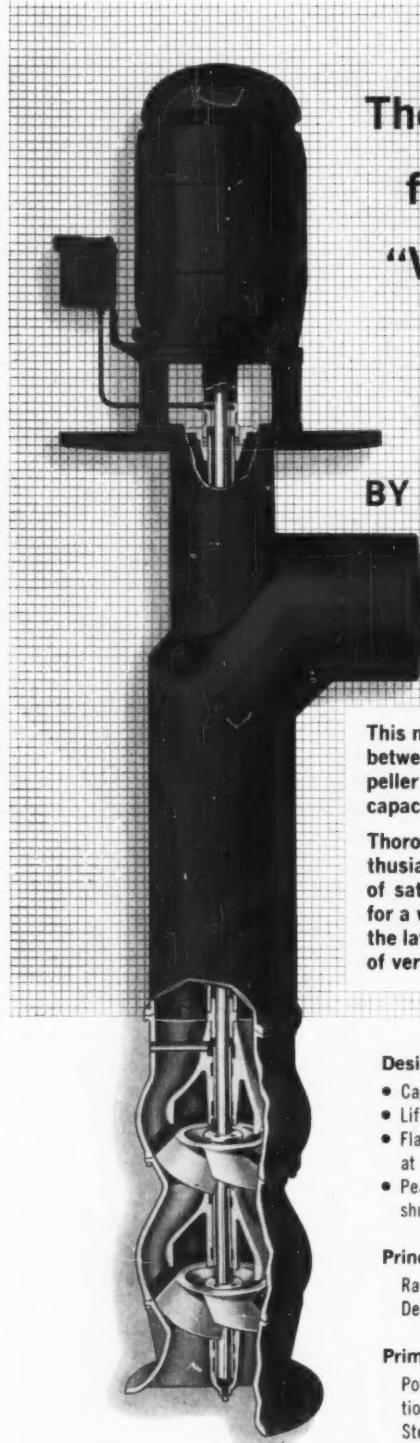
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This is the ultimate test of a service-entrance device. Will it open in an emergency—after remaining closed for years, with little, if any, maintenance? The fused Pringle switch does. Against any overload. Its contacts are bolted together by a simple, rugged toggle mechanism that turns a bolt through the blades, pulling them together, tight against the fixed contacts. There is nothing to loosen, stiffen or fatigue. Nothing that needs any maintenance. Bolted contact pressure is constant, independent of springs, unaffected by heat. It permits this switch (1200 to 5000 amps) to carry full load continuously, with a heat rise at the contact areas considerably less than the accepted 30° C.

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This new Johnston fills the “vital gap” between low head—large capacity propeller pumps and high head—smaller capacity regular turbines.

Thoroughly field-tested and already enthusiastically recommended by a score of satisfied users, it is now available for a wide range of applications and is the latest addition to the Johnston line of versatile vertical pumps.

Design Features:

- Capacities exceeding 100,000 gpm.
- Lifts from 20 to 60 feet.
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- Peak performance at 40 to 60% of shut-off head.

Principal Applications:

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vidual to an individual, engineering lends itself to a group service.”

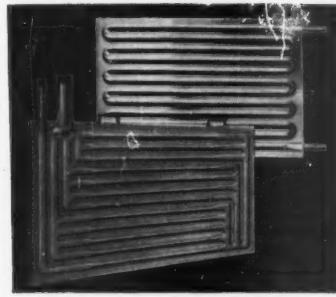
¶ The National Society of Professional Engineers has taken no position on the proper business structure for an engineering firm, so long as the man in charge is a registered engineer. Co-chairman of the committee that prepared the section on corporate practice was Robert Williamson, Jr., who also has been serving as the chairman of NSPE's registration committee.

Commenting later on the corporate practice provision of the Model Law, Williamson said various controls suggested for corporate structure (stock ownership, composition of board of directors, registration of officers) were unworkable and would, in effect, limit the application of the law to consulting practice only. “To me, this is just about as far back as we could step in our efforts to advance the profession . . . every engineer, regardless of where he works, for the government, public utilities, manufacturers, or any place where . . . the safeguarding of life, health, or property is involved, should be a registered and licensed engineer.”

CEC director Lyford went even further. “I think Macy's should be allowed to offer engineering services to the public so long as the individual responsible for the engineering is a registered graduate engineer. Registration laws were made to protect the public, not to guarantee a livelihood to consulting engineers or to anyone else.”

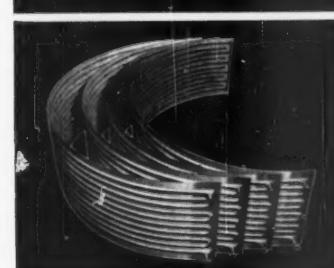
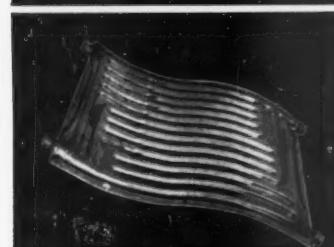
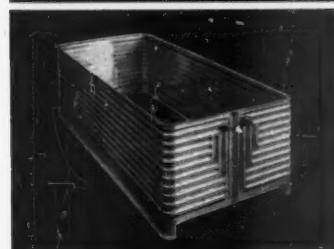
One Blank Wall

The Committee on Engineering Laws dates back to 1952, when New York State passed a law requiring all corporations practicing engineering in the state to register every two years. Under New York's grandfather clause, only those corporations formed prior to 1935 can practice engineering in the state, but until 1952 corporate practice was not much of an issue. Some post 1935 engineering corporations



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TO DIFFICULT
HEAT TRANSFER PROBLEMS

Now you can apply the engineering, installation, operational and maintenance advantages of PLATECOIL to more tank and process heating and cooling problems than ever before. Standard units with exclusive "MULTI-ZONE" pass design for faster heat-up and temperature recovery or serpentine pass arrangement satisfy many requirements. These "standard" styles, available in a wide variety of sizes can be factory-fabricated into banks to fit the application. PLATECOIL can be formed and rolled to specified diameters or even fabricated to form tank walls.

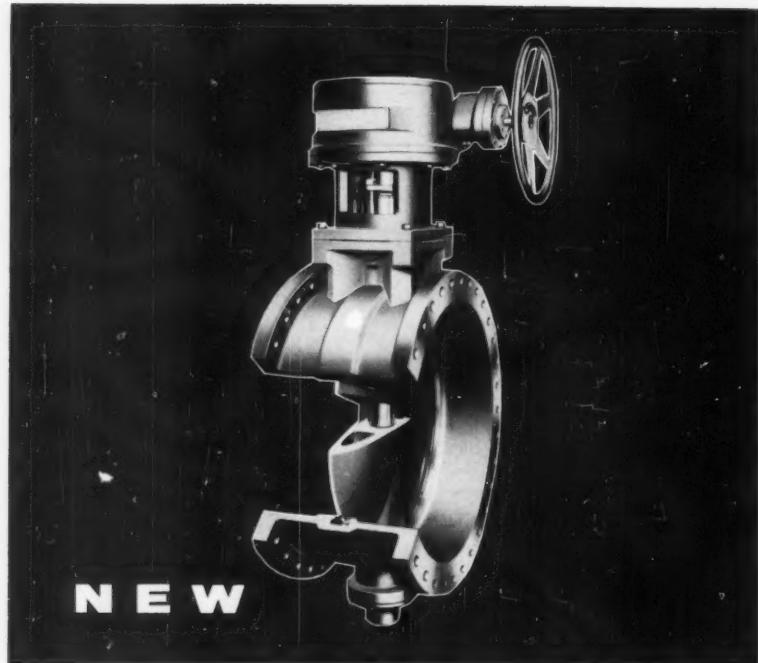
PLATECOIL provides a "packaged" answer to many heat transfer problems, avoiding costly engineering and fabricating of pipe coils. Units are easy to install and maintain—with simple connections, light weight, and streamlined surfaces. High heat transfer capacity permits compact, space-saving units.

Both "standard" and specially built PLATECOIL are available in mild steel, stainless steel, Inconel, Monel, Ni-O-nel, Hastelloy B, C and F, Nickel and other weldable materials. Operating pressures up to 250 psig. Safety factor—5 to 1. Double embossed or one side flat. Complete engineering data and assistance available.



Ask for Bulletin P85.

PLATECOIL®
DIVISION



PRATT Rubber Seat Butterfly Valves Have Adjustable Seat

The new Pratt Rubber Seat Butterfly Valves have many important design features, but perhaps the most significant is the adjustable rubber seat. By virtue of this design, it is now possible to offer such operating advantages as:

1. **EASIER OPERATION**—made possible by the most precise fitting of the seat.
2. **EASY FIELD REPLACEMENT**—Now, in accessible pipe lines, valve seats can be adjusted (or even replaced) without dismantling valve, or removing it from the line. Further, field seat replacement jobs will be factory-accurate.
3. **LONGER OPERATING LIFE**—through accurate control of disc-seat interference, giving tightness without wear.
4. **HIGHER OPERATING PRESSURES**—up to 150 psi.

Pratt Rubber Seat Butterfly Valves are available in all AWWA classifications, and for pressures to 150 psi for industrial service, in sizes through 14".

RUBBER SEAT Butterfly Valves

HENRY PRATT COMPANY
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*Creative
Engineering for
Fluid Systems*

were surprised to find that they were operating illegally.

In 1952, seven corporations, all safely under the grandfather clause, organized in an effort to get the New York law changed. These CEL founder firms are Burns & Roe Inc., Chemical Construction Corp., Day & Zimmermann, Inc., M. W. Kellogg Co., The Lummus Co., Stone & Webster Engineering Corp., and United Engineers & Constructors.

They were unable to do anything about the New York law that year, or since, for the New York State Society of Professional Engineers, the New York State Association of Consulting Engineers, and the New York City Association of Consulting Engineers perennially oppose a wide-open engineering policy for the state. As Lyford rightfully points out, New York has a ridiculous situation in regard to corporate practice. Under the grandfather clause, 119 corporations are allowed to practice because they were formed prior to 1935. However, the Manhattan telephone book alone lists more than 300 corporations offering engineering services.

Complaints are made regularly to the State Education Department; the Education Department reports to the Attorney General; and that ends it. The CEL as a group would not mind a test case, but no individual member wants to initiate a court action.

A Few Open Doors

Judging CEL by its failure to change the law in New York State would be a mistake, however. Since CEL was formed, no state has passed a bill prohibiting corporate practice, and 10 states have adopted corporate practice bills meeting CEL approval. Some of the 10 states already had corporate practice bills of sorts, but the new bills are more definitive.

CEL is not the fountain of unlimited funds many of its opponents think it to be. The annual budget runs from \$75,000 to \$100,-

Thousands of Firms Have Profited from **AUTH SIGNALING EQUIPMENT!**... Has Yours?



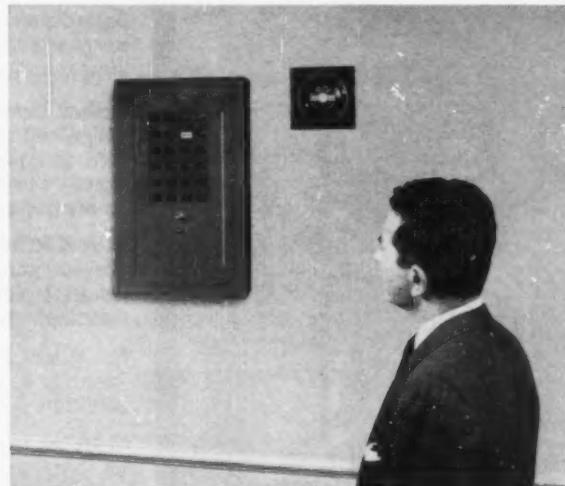
FOR HOSPITALS: Nurses' Call, Doctors' In-and-Out, and Paging Systems; also, Clock, Fire Alarm Systems, and Ground Detectors.



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FOR APARTMENTS: Apartment House Telephone and Bell Systems; also, U.S. Approved Mail Boxes and Non-Electric Door Chimes.



FOR INDUSTRY: Supervisory Annunciators, Audible Signals, and Push Buttons; also, Fire Alarm and Clock Systems.

The name AUTH on electrical signaling, time, and communication equipment conveys different meanings, all of which can be summed up in one word—profit!

To owners—and their representatives, the architectural and engineering firms—Auth stands for capable assistance in planning requirements, excellent prod-

uct performance, and minimum upkeep. To distributors, Auth means easily-consumated orders at the right price—without rejections, delays, or excess paperwork.

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Everyone profits when fine equipment—as made by Auth—is specified, purchased, and installed.

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Auth Electric Company, Inc.
LONG ISLAND CITY 1, NEW YORK

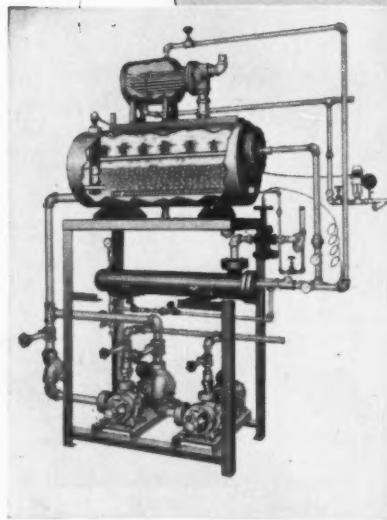
SPECIALISTS IN ELECTRICAL SIGNALING AND COMMUNICATION SYSTEMS AND EQUIPMENT

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-continuous boiler feed water
deaeration under .005 cu liter
without vent loss or adjust-
ment, over a 10-to-1 load swing.
without sodium sulphite

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Day-in-day-out under boiler load
swings as great as 10-to-1—not just
under favorable fixed test conditions.

Excellent thermal efficiency
(insignificant steam vent loss)
under all regular operating con-
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for any load change.

No need for sodium sulphite or
other additives. (If you need 'em, you
just aren't getting full mechanical
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Plus at least 6 other savings in
operations, maintenance and
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All are the result of the unique,
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for external superheating, explosive
flashdown and fully-vented operation.

SCHAUB ZERO-OXYGEN deaerators

GET THE FULL FACTS--SEE YOUR SCHAUB REPRESEN-
TATIVE OR SEND FOR BULLETIN 575. EITHER WAY YOU
WILL PROBABLY CHANGE YOUR IDEAS ON WHAT CON-
STITUTES TRUE DEAERATION OF BOILER FEED WATER.

FRED H. SCHAUB ENGINEERING COMPANY

5303 Belmont Road, Downers Grove, Illinois

CLIP AND ATTACH TO YOUR LETTERHEAD

Please send my personal copy of Bulletin 575

Name _____

000, depending on how many states have pending corporate practice legislation. Providing financial assistance to groups sponsoring legislation is rare for CEL. Lyford said that money was donated in only one state — to an NSPE group sponsoring a bill.

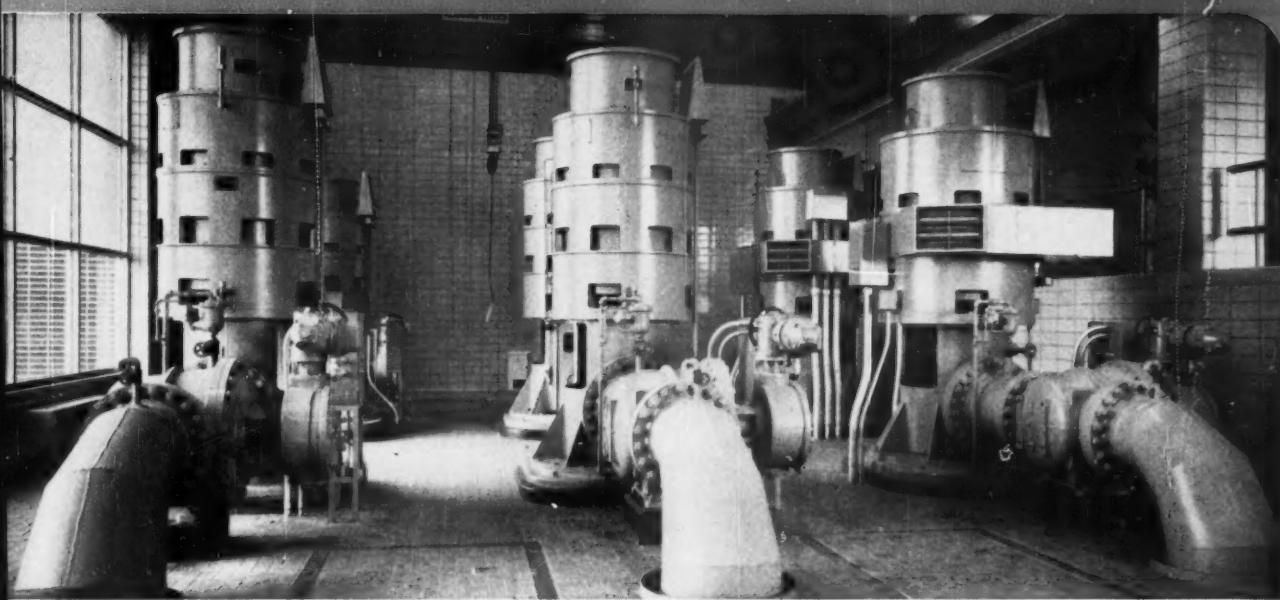
Lyford gave a typical example of how CEL handles proposed legislation. "We usually learn about the pending legislation through a legislative reporting service or through the grapevine. Let's assume this hypothetical state is considering passage of a registration law with no mention of corporate practice. We first find out who is sponsoring the bill, hoping it will be one or more engineering societies. Then we present our ideas, and, if the sponsors agree with us, our attorneys help them draft a satisfactory amendment to the registration law. If the sponsors do not agree with us, we usually find at least one member who will submit an alternate amendment."

Some Loopholes

In states prohibiting corporate practice, corporations have so common a method of circumventing the law that many wonder why CEL would bother to try to change it. If a corporation wants a New York State project, several key men in the corporation form a partnership. But there are drawbacks to this, both for the corporation and for the individuals. All employees must legally sever corporate ties before going to work for the partnership, and the staff loses seniority, insurance, pension rights, and other benefits. The employees, understandably, do not like the system.

Another common way to get around an anticorporate practice law is to ignore it. There is, however, the possibility that a client could refuse to pay a corporation practicing illegally. As the CEL attorney points out, "There is a considerable body of law which holds that in order to recover for serv-

City of Springfield, Ohio



PLenty of WATER for Springfield-66 MILLION GPD Max.

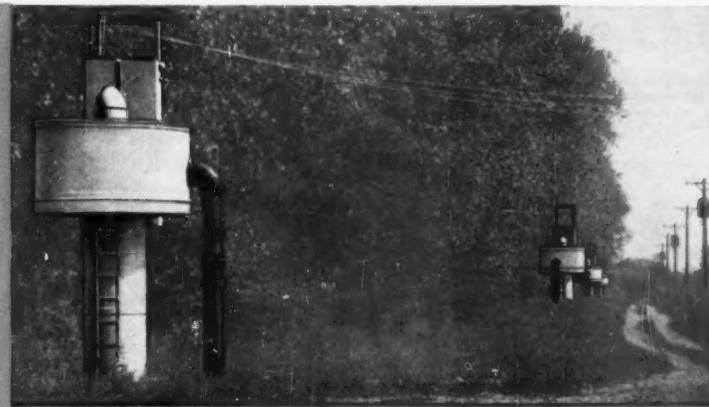
Springfield, Ohio has a completely new, automatic water supply system by Layne. It guarantees 66 million gallons per day for their present and future needs—a job complete by Layne—and a completely satisfied customer. Field Tests exceeded the guaranteed pump efficiencies by 1% to 2% on all units. Consulting Engineers: Black and Veatch, Kansas City Missouri. Water Supply Contractors: The Layne Ohio Company, Columbus, Ohio. Do you need complete water service? Get it from Layne. Write for Bulletin 100.

Specifications

RAW WATER—10 Layne Gravel Wall Wells with Layne 18-8 Stainless Steel shutter screen and 10 Layne deep well pumps. 2800 GPM — 65 ft. TDH, 75 hp—440 Volts—1750 RPM, located in two banks pumping to the filter beds. Pumps were installed 15 feet above ground level for flood protection.

FILTERED WATER—Six Layne high service pumps boosting filtered water into distribution system. Five are 12 MGD-285 ft. TDH, 700 hp—4160 volts—1185 RPM. Two are variable speed units. The sixth Layne Pump is a 6 MGD-285 ft. TDH, 400 hp—4160 volts—1185 RPM. All pumps operate through the central control panel.

LAYNE OFFERS COMPLETE WATER SERVICE: Initial Surveys • explorations • recommendations • site selection foundation and soil-sampling • well drilling • well casing and screen • pump design, manufacture and installation construction of water systems • maintenance and service • chemical treatment of water wells • water treatment—all backed by Layne Research. *Layne services do not replace, but coordinate with the services of consulting, plant and city engineers.*



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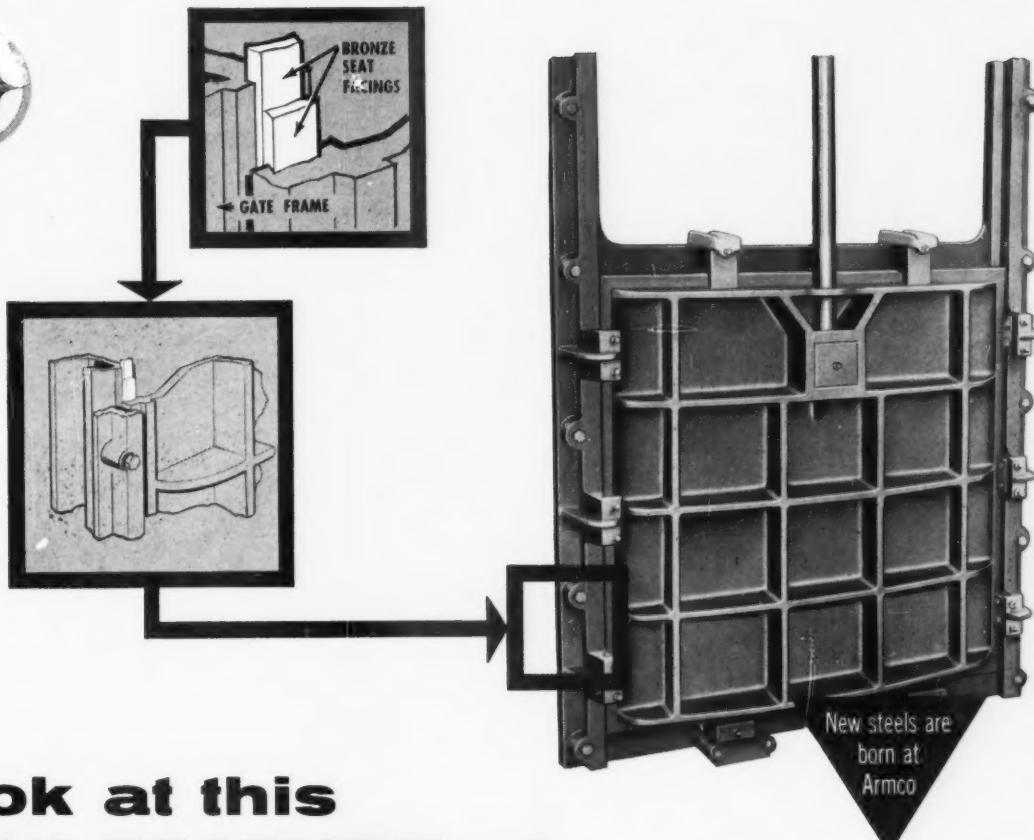
ices rendered in a professional field covered by a licensing statute, the person rendering such services must plead and prove compliance with the statute. If he cannot do so, he will be denied recovery."

CEL's attorney, W. B. Stitt, also points out a seldom-used method of avoiding corporate practice restrictions. "Since a prerequisite of the exercise of police power is the protection of the public, the question arises whether a state can properly prohibit the execution within its borders of designs prepared in another state; further, whether the use of designs prepared by a corporation in a state permitting corporate practice can be prohibited in a state where such practice is not permitted. At least one case indicated that if the engineering is permitted in the state in which it is done, the contract is valid even though such engineering would not be permitted in the state where the designs are to be used." Smuggling plans from New Jersey to New York could become as popular as taking microfilmed plans from the United States into Canada.

CEL'S Defense

To justify its stand on corporate practice, CEL has two basic arguments. In Stitt's words: "Since engineering registration laws represent an exercise of police power, it must be noted that such power may only be properly exercised for the welfare of the public as a whole — not exclusively for the benefit or economic welfare of any one group, or the law would be unconstitutional class legislation."

"Philosophic opposition is based on a misguided idea that the practice of engineering is similar to that of other professions such as law and medicine. It is based on the theory that engineering is a learned profession, which historically is not the case . . . the ethics of the engineering profession revolve about an entirely different axis from the ethics of law and medicine. New York, for instance, recog-



Look at this NEW FEATURE of Armco Sluice Gates

Now you can get Armco Sluice Gates with bronze seating faces tightly anchored into dove-tailed grooves on both the slide and the frame. Both edges of the seating faces have the support of their beveled sides, with no overhanging surfaces. The actual bronze seating surfaces are machined perfectly flat for maximum watertightness.

This is just one advantage of Armco Sluice Gates. Others of special interest to engineers are: flush bottom opening; adjustable wedges; and a choice of metals for mounting materials. Then too, Armco offers you the world's widest selection of sluice gate sizes. See table for condensed data.

For more information on Armco Water Control Gates, write us, mentioning the type of gate that interests you. Armco Drainage & Metal Products, Inc., 6430 Curtis Street, Middletown, Ohio.

SIZE RANGE and permissible unbalanced heads

Type of Gates	Sizes		Permissible Unbalanced Head	
	Round Openings	Square and Rectangular Openings	Seating in feet	Unseating in feet
Sluice Gates	6" to 120" diameters	6" x 6" to 108" x 108"	5' to 100'	0' to 30'
Flap Gates	4" to 90"	24" x 24" to 96" x 96"	10' to 50'	—
Roller Gates	—	9" x 6' to 30' x 12'	0' to 15'	0'
Radial Gates	—	8' x 3' to 20' x 7'	0' to 10'	0'

ARMCO DRAINAGE & METAL PRODUCTS

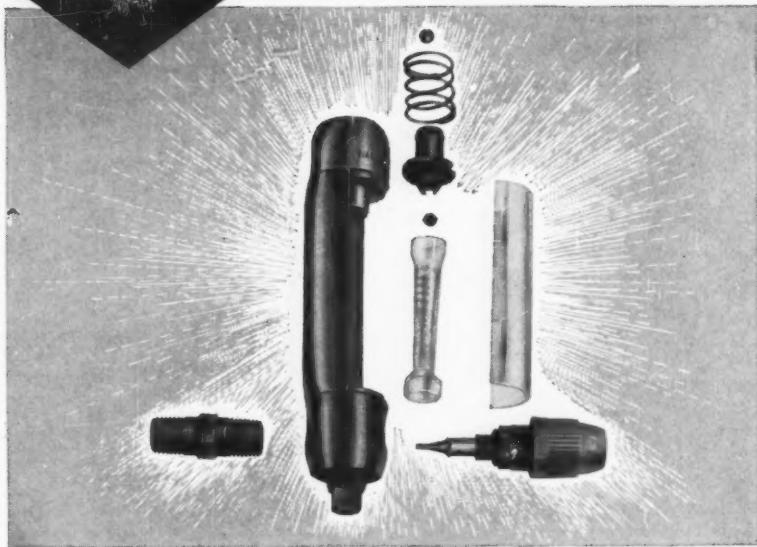


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The Varea-meter's all-stainless, unitized frame shrugs off pipe strains, resists corrosion. There are no small screws or bolts to "freeze"; "O"-rings give permanent, leak-tight sealing. And the Varea-meter's stainless spring really lasts. It's positioned outside the flow stream . . . locks the tube in place externally.

For truer flow indication, a new high-stability float assures foolproof measurement. And for extra convenience, control valve may be placed at the inlet or outlet.

For economy, W&T Varea-meters convert for increased or changed flows with the meter right in the line. And 90% of all parts are interchangeable whether the scale length is 1½" or 3".

There are 29 tube capacities for both scales. Maximum flows for both are 40 gph of water, 110 scfh of air.

Full details and easy-to-order form are ready now. Write Dept. V-1.25.



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nizes by statute a confidential relationship which exists between a clergyman, a doctor, or a lawyer and their respective parishioners, patients, and clients, and protects such confidential relationship. There is no similar recognition of a professional obligation creating a relationship of confidence with respect to engineering . . ."

And, Lyford points out, consulting engineers could get laws so restrictive that they would hurt their own practices.

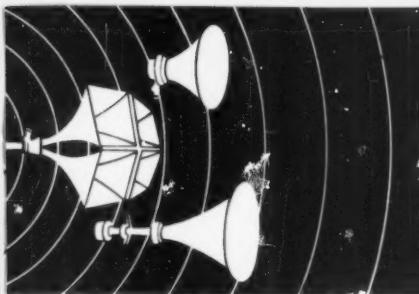
Present Standings

The current corporate practice picture shows engineering by corporations allowed, but limited by requirements as to certain personnel, in Alabama, Colorado, Georgia, Hawaii, Massachusetts, Minnesota, Mississippi, Montana, Nevada, New Jersey, North Carolina, South Dakota, Wyoming, Arizona, Arkansas, California, Florida, Illinois, Indiana, Oklahoma, Oregon, Iowa, Maine, Nebraska, Texas, Utah, Vermont, West Virginia, Michigan, Missouri, New Mexico, Pennsylvania, Tennessee, Washington, and Wisconsin.

Although the statutes do not clearly permit corporate practice, State Boards have given opinions that it also is legal in Delaware, Kansas, North Dakota, and South Carolina.

Corporate practice is prohibited, and penalties provided, in Kentucky, Louisiana, and Rhode Island. It is allowed only under grandfather clauses in New York, Ohio, and the Canal Zone. According to opinions or rulings by state authorities (not statute), corporate practice also is not allowed in Connecticut, Idaho, and Virginia. Court decisions have interpreted the statutes of the District of Columbia and Maryland as prohibiting corporate practice.

The gray areas are Alaska, New Hampshire, and Puerto Rico, where the statutes are untested but could be construed to prohibit corporate practice.



AUDIO NEWS

for consulting engineers



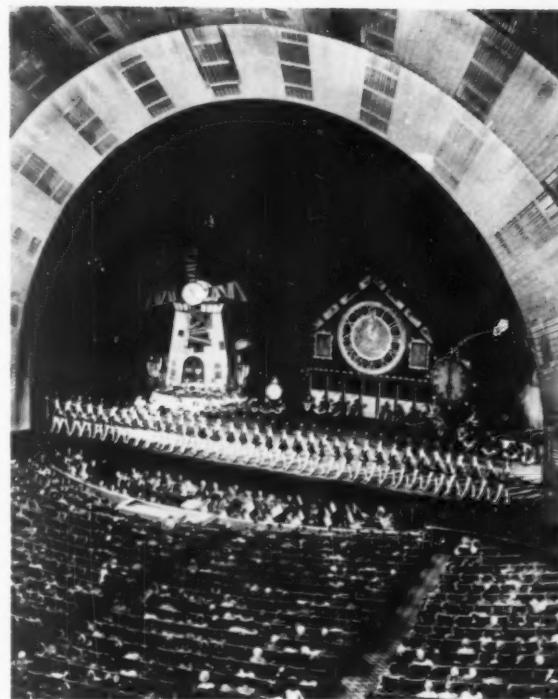
RADIO CITY MUSIC HALL: GREATER ENTERTAINMENT THROUGH CONTROLLED ACOUSTICS

Like the staccato tapping of a Rockette routine which it serves to amplify, the RCA sound reinforcement in Radio City Music Hall is a triumph of precision planning and execution. It is a system in which every component is designed and positioned to most effectively exploit and enhance the natural acoustics of the auditorium.

The purpose of each sound re-enforcement system installed at the Music Hall—from the original single channel installation of 1932 to the first stereophonic system which was the sensation of 1935, to the present flexible and elaborate 3-channel system—has always been to provide greater entertainment and better listening through controlled acoustics.

To achieve this goal, a careful study was made to determine the total acoustic energy heard at any point in the auditorium. This study included an analysis of the acoustical characteristics of the auditorium—echo reflections, reverberant reflection, extraneous noise and distortion. The net result: precise knowledge and control of the degree and quality of sound transmitted to every seat in the theatre, and a sound system capable of achieving "good listening" as well as brilliant and dramatic effects.

The present Music Hall sound system is of the three channel type which permits directional control and stereophonic effects depending on the requirements of a particular scene. There are a total of eighty-nine microphones positioned about the stage, footlights and orchestra. These are patched and mixed at the console which is housed in the sound control booth, a compact open-fronted box located to the left of the film projection booth, high above the audience. For ease of control, the individual mixers for the microphones are banked in left, center and right tur-



Seven radial horn loudspeaker systems are hidden behind the lighting grilles in the proscenium arch at Radio City Music Hall.

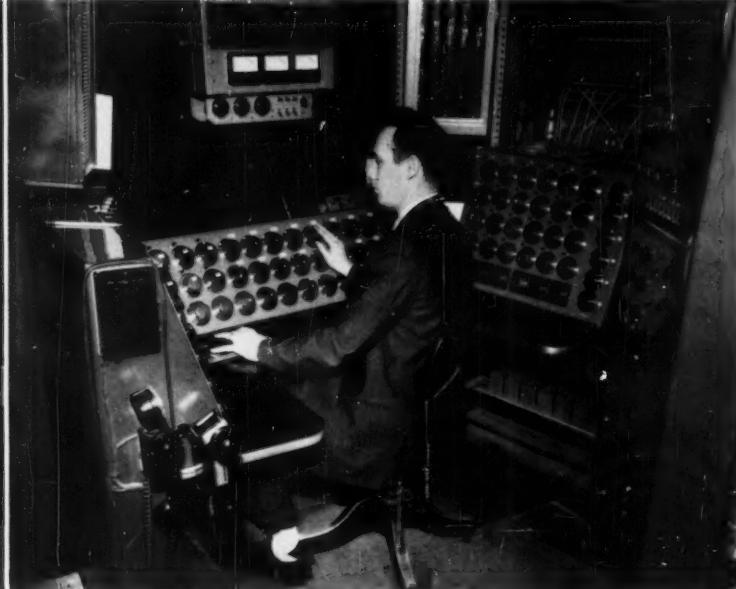
rets; each turret also contains six sub-master mixers which may be mechanically ganged in "pairs" or "threes" when desired.

An equipment room, adjacent to the sound control booth, houses the amplifiers for the system. Each sound channel is powered with two rack-mounted 35 watt theatre type amplifiers. A meter on the case of each amplifier indicates condition of the amplifier, eliminating the necessity of trial and error testing.

AUDIO NEWS for consulting engineers



Music Hall sound director checks equipment in amplifier room.



Mixing of as many as 89 microphones is controlled from this compact sound control booth.

FLEXIBLE RCA SOUND SYSTEM SERVES RADIO CITY MUSIC HALL

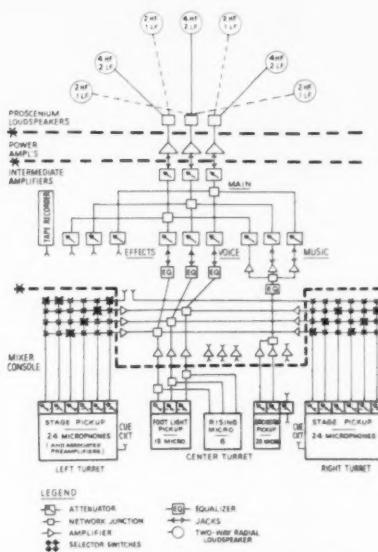
Loudspeaker systems for Radio City Music Hall are housed in the proscenium arch. Seven theatre type two-way radial horn loudspeaker systems are hidden behind the lighting grilles in the proscenium wall. Three of these systems are connected to the center sound channel for full coverage of the auditorium while two systems are connected to each side channel for directional effects.

Twenty high frequency and ten low frequency drivers are used in the complete system. The total audio power of the system is 280 watts which frequently is fully utilized for sound effect purpose.

The success of the Radio City Music Hall sound system can be attributed to two key factors: precise planning, and an unwavering desire to provide highest quality sound re-enforcement to enhance the entertainment value of stage and screen performances.

Relatively few sound systems are critical enough to require special acoustical analyses. But for those installations that do require acoustical perfection, we will be glad to have our staff acoustic engineer work with you.

RCA Audio Product Distributors are prepared to provide specification and performance data or other information or assistance you might need on the more than 500 audio products available from RCA. Look in the classified directory under "Public Address and Sound Systems." Or write Audio Products, Radio Corporation of America, Building 15-1, Camden 2, New Jersey.



Line diagram of Radio City Music Hall sound re-enforcement system.



The Most Trusted Name in Sound

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Stations are clean, easy to maintain and trouble free . . . specially when Smith & Loveless quality is built into them. No detail is overlooked to make Smith & Loveless Lift Stations as automatic, efficient and dependable as possible.

Smith & Loveless Stations are economical to install and save you money over the "long

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If you have a sewage "lifting problem" in your project, write for our complete engineering data manual. Address: Department 120.

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How Commonwealth Edison Turned a Fly Ash Problem Into Profit

At Commonwealth Edison's State Line Station, about 350 tons of fly ash a day had to be wet down, loaded, and trucked to suitable dumping sites.

Waste becomes profit. Today, the plant burning a peak load of 5000 tons of coal daily collects dry fly ash automatically in a totally enclosed Fuller-Kinyon system. The ash is conveyed from precipitators to storage bins and silos, where it's sold as a by-product. Manpower: just three men, one at the main control panel and two bagging the ash.

Air and gravity do the work. F-H Airslide® conveyors fluidize dry fly ash by a column of low-pressure air for easy movement by gravity to central surge hoppers. Then, a Fuller-Kinyon pump under each hopper drives the ash by air through a five-inch line to storage. The system is practically maintenance-free. There are few moving parts to foul or wear out.

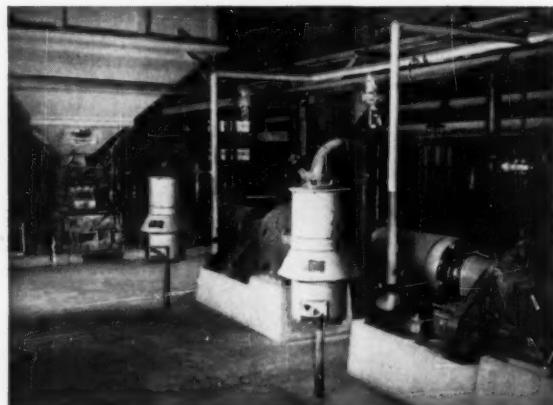
Large and small plants can get the benefits of Fuller-Kinyon fly ash handling. Capacities range from 100 to 8,000 cubic feet an hour. F-H Airslide and Fuller-Kinyon conveying lines can be curved to avoid beams and other obstacles. Low-pressure air provides power inexpensively and installation costs are significantly less than other types of conveying systems. Write for detailed information in Bulletin FF-49-1.

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Plant Maintenance Show
January 23-26

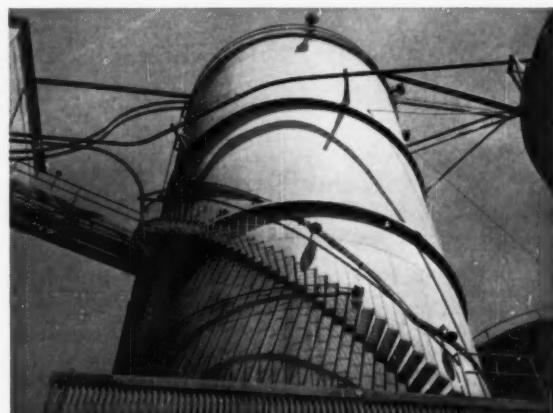
1335A
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F-H AIRSLIDE FLUIDIZING CONVEYORS ANGLE DOWNWARD from precipitator hoppers, move air-activated ash to 20-ton central surge hoppers under floor. There are few moving parts.



FULLER-KINYON PUMPS AND COMPRESSORS under surge hoppers propel ash to bins and silos at 20 tons an hour. Fluidized by air, the abrasive, 300°F. ash moves without injuring system.



BULK SILOS receive air-conveyed ash through Fuller-Kinyon pipe-lines. Farthest silo is 1,000 feet from pumps. Over 50% of fly ash is bagged and sold as a by-product.

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SUBSIDIARY OF GENERAL AMERICAN TRANSPORTATION CORPORATION
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Men and Firms

A. G. Odell, Jr., and Associates, architects, of Charlotte, North Carolina, has established its own engineering department. The Odell firm has obtained additional space in the Independence Building to house the new department, which is headed by Emmett W. Bryan. Bryan formerly was a partner of Bryan and McDowell in Charlotte. His partner, J. M. McDowell will continue in business under his own name and Bryan will remain associated with him until present contracts are completed.



BRYAN



POLLARD

Harland Bartholomew and Associates, St. Louis, Missouri, has established an office in Memphis, Tennessee, under the resident direction of William S. Pollard, Jr., partner in the firm. The new office, located at 188 Jefferson Avenue, will offer the full professional services of the firm.

Charles H. Sells, Inc., consulting engineers and surveyors, has

opened a new office at 61 Maple Avenue, New City, New York. Donald C. McGilvray, Jr. is manager of the new branch office. The firm also has offices at Pleasantville and Rochester.

Ray E. Lawrence, partner in the firm of Black and Veatch, consulting engineers, Kansas City, Missouri, was elected to the presidency of the Water Pollution Control Federation by the Election Committee at its recent annual meeting.

L. William Wood has been elected vice president, surveying, of Johannessen & Girand, consulting engineers, of Phoenix, Arizona.

Harvey O. Banks, Director of Water Resources, State of California, has announced that he will retire from state service in January 1961 to enter private practice as vice president of Leeds, Hill and Jewett, Inc., consulting engineers, Los Angeles and San Francisco. Banks will specialize in water rights and ground water problems and in the planning, financing, and administration of private and public water resource developments.

A new consulting office has been opened in San Francisco by The Kuljian Corporation, engineers and constructors, of Philadelphia. Albert F. Kerss, a resident of Cali-

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CONVEYOR-SCALE SYSTEMS**



With a W-C Conveyor-Scale System incorporated in your process scheme, you can have up-to-minute thru-put data at any point from incoming transfer to inventory stock-pile. This data, expressed in terms of weight per unit of time, can be totaled for inventory records, process programming, or other manufacturing and accounting functions.

W-C Conveyor-Scale Systems can be supplied for flat or trough-type belts, fixed or variable speed, in capacities from 20 to 1000 tons per hour for new or existing conveyor installations. Each is a job engineered system employing standard, unitized components. As a result, you get a "custom" system at an "off-the-shelf" cost.

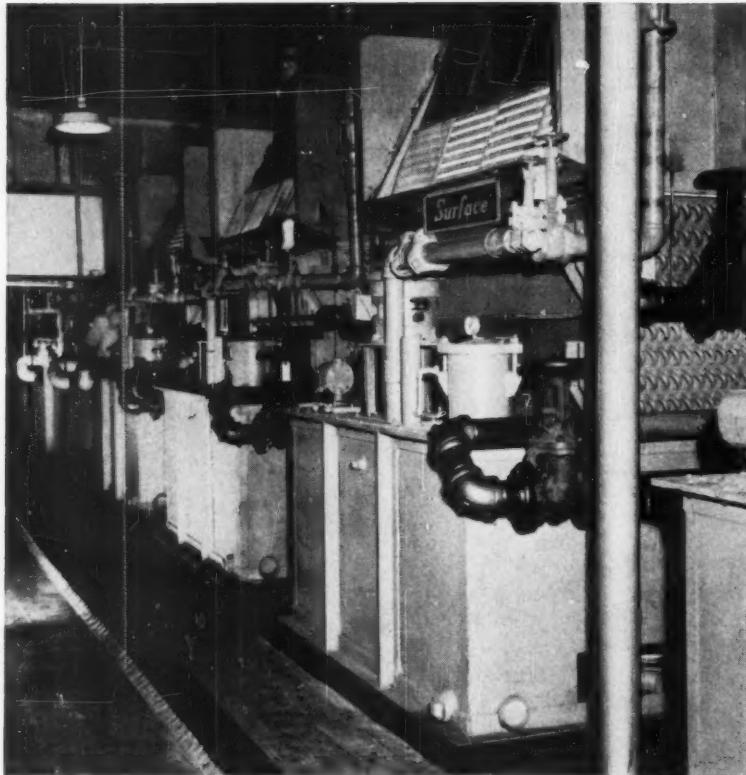
Typical applications include:
Controlling feed and blending
of formulation materials
such as naptha, phosphates,
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Write for new Bulletin 60



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120 GRAINS CUT TO 45 IN 200,000 cfm OF AIR WITH 85° TOWER WATER

Without Kathabar, this job would have taken 1800 tons of refrigeration, at about 35F and reheating air from about 45F to 98F! With Kathabar the job took 63 hp instead of 2000. Ask the men who have seen Kathabar Type C units serve for years with practically no maintenance. Write for specific information.



SURFACE COMBUSTION

Division of Midland-Ross Corporation



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Send facts on Kathabar systems for the following application:

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city _____ zone _____ state _____

fornia since 1944, with 20 years experience on a wide variety of engineering projects here and abroad, has been appointed manager of the new San Francisco office. Address of the new office is Van Ness-Post Center Building, 1255 Post Street.

Theodore M. Chubb, formerly chief engineer and general manager of the Department of Public Utilities & Transportation for the City of Los Angeles, has joined H. Zinder & Associates, consultants, as director of the firm's Pacific Southwest Division.

At the same time, it was announced that H. Zinder & Associates is opening permanent offices in Los Angeles. Other offices are located in Washington, New York, Dallas, Seattle, and San Francisco.



CHUBB



VAN HOUTEN

Leonard E. Van Houten has been appointed vice president of Frederic R. Harris, Inc., consulting engineers of New York City. Van Houten, who is presently in charge of the firm's office in The Hague, Holland, is a specialist on the design of marine terminals for the handling of petroleum and petroleum products.

The firm name of Michigan Associates, consulting engineers, of Lansing, Michigan, has been changed to John R. Snell Engineers Inc. Officers and principals of the firm include: John R. Snell, president; John M. Fairall, vice president; William G. Turney, treasurer; and William T. Harvey, secretary.

Here's How KENNEDY'S Design and Construction Features Give You Greater Value for Your Valve Dollar...

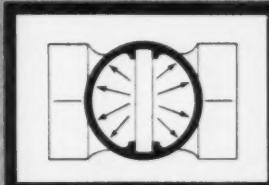


Fig. 525
125-Pound SWP Bronze Gate Valve
Union Bonnet · Rising Stem
Inside Screw · Wedge Disc

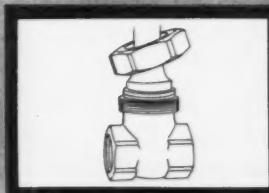
KENALLOY Stem . . . standard with Kennedy! Is strongly inhibited against desiccation and corrosion. It is a long-wearing metal for longer easier operation.



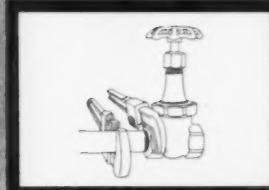
Cylindrical Body withstands sudden pressure. Kennedy's Cylindrical Body construction resists rupture and minimizes deflection when under severe pressure.



Heavy Bronze Union Bonnet Ring is entirely separate from the bonnet to eliminate any possibility of springing the bonnet face when assembling or disassembling the valve for cleaning or inspection.



The Kennedy wider hex ends are blended into body making the body and hexes one unit. This rugged construction prevents distortion and wrench pressure is absorbed.



These additional advantages make KENNEDY your best valve buy . . .

Fig. 525 . . . newest in the valve field . . . best in the valve field. Fig. 525 gives greater strength with less bulk and weight than any comparably rated valve.

Kennedy's Fig. 525 can be repacked under pressure thus eliminating line shut-down. Simply open valve fully, remove packing nut and repack.

Threads in the KENALLOY Stem are ac-

curately machined to eliminate feather edge ends which in ordinary valve stems break off and lock the stem in the bonnet. This accurate machining means easier operation and longer valve life.

The joint between the body and the bonnet is bronze-to-bronze true union. Generally accepted as the most satisfactory type of union joint.

• YOU CAN'T BUY A BETTER VALVE THAN A KENNEDY!

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Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas





The Squeeze - Cities Without Space, by Edward Higbee; William Morrow and Company, Inc., New York, N.Y.; \$5.95.

Engineers must prepare now to accommodate the vastly greater populations that are clearly coming, for it will not be long before there is standing room only in the cluttered heart of metropolis."

Here is a book that might well have been written by Vance Packard. The fact that it was not is probably unfortunate. For the problems of our crowded cities and the gradually disappearing acreage for suburban development could stand the strident — and attention getting — argument of the Madison Avenue set. As a critic of advertising, Packard's books consistently seem to get more attention from this group than they deserve. It is unfortunate that Higbee has no such advantage to draw attention to his new book.

It is Higbee's contention that a nation's cities should reflect the character of its people. If this is true, we are in trouble. For Chicago's lake front and Pittsburgh's Golden Triangle are two of the very few big city areas for which Higbee has kind words.

The cities' biggest need is, of course, money. According to Higbee, "In 1932, incredible as it seems, all cities lumped together collected \$2.6 billions in taxes. All states as a group collected \$2.3 billions. The Federal government, with beginner's modesty, assessed its citizens only \$2.0 billions. By 1955, . . . people no longer had

Parallel Reading for Consulting Engineers

to worry about how to dispose of their incomes. The bureaucrats, without much solicitude, were doing the job for them. Cities taxed them \$11 billions. States collected \$20 billions, and the Federal government skimped along on \$73 billions, while entertaining dreams of more." Thus, the cities, which we have expected to support parks, art museums, theaters, and museums, are shortly going to be unable to pay the bill for these important contributions to our culture. As a city's tax base shrinks, its tax rate rises, and it is not surprising that the more affluent citizens seek refuge in the suburbs.

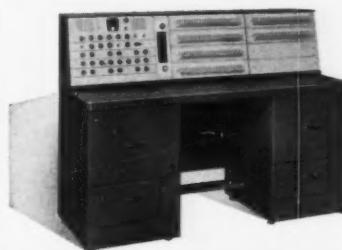
However, suburbia itself is in deep trouble. For every new family blotting out the farm lands that used to ring our large cities, there is required an investment of thousands of dollars for community services. Unfortunately, the single family residence seems to be unable to generate the necessary capital in the form of taxes. Thus, the suburb either must do without parks, playgrounds, and adequate schools; or it must invite industry within its borders; or pass a bond issue. The fact that this is often done without adequate planning may simply complicate the already serious problems for the future.

It is to Higbee's credit that he recognizes the role of the engineer as the only professional planner capable of coordinating urban and suburban growth. But he also recognizes that the engineer cannot do an effective job until we have

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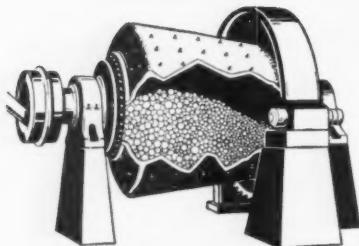
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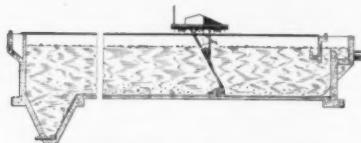
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Bulletin 100-B-64

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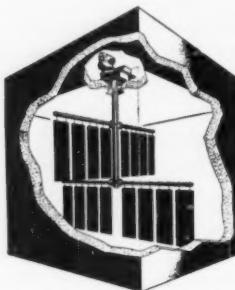
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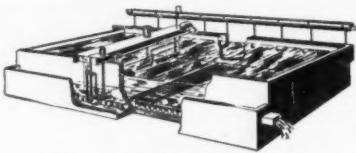
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There are seven distinct types of Ruggles-Coles Double and Single Shell Rotary Dryers, designed for direct, indirect and steam heat in from four to ten sizes for each type. Rotary Kilns also offered in sizes up to 100' in length.



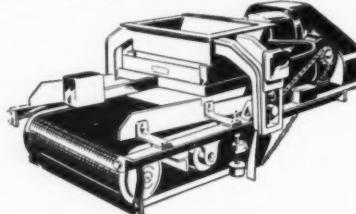
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cleaned up the mess created by our competing and overlapping public authorities in the metropolitan areas. Higbee strongly recommends such super city organizations as Dade County, Florida's Metro, which brings Miami and 25 other Florida communities together. Only with such political integration can the engineer be turned loose to do his job. In our nation's 174 largest metropolitan areas there are, according to the 1957 census, 3422 municipalities — an average of 20 for each.

New Technical Books

PROGRESS IN DIELECTRICS, Vol. II, edited by J. B. Birks and J. H. Schulman; John Wiley & Sons, Inc., New York; \$9.50. This second in an annual series of volumes deals primarily with dielectric properties in weak electric fields. It contains six critical reviews of the present state of knowledge and research in the main topic. Both American and British experts have made contributions from their own specialized fields.

RUNNERLESS MOLDING, by Ernest P. Moslo; Reinhold Publishing Corp., New York; \$4.95. This is a concise (160 pages) survey of the theory, design, application, and economics of injection molding for plastics and related industries. It is well-organized and illustrated.

HOW TO CHART DATA, by Phil Carroll; McGraw-Hill, Inc., New York; \$7.50. Mister Carroll, an engineer, presents his patterns for the use of charts in work measurement, plant scheduling, and cost control. He presents the data necessary for solving various problems, and his approach to their solution.

MATERIALS SELECTION FOR PROCESS PLANTS, by Russell E. Gackenbach; Reinhold Publishing Corp., New York; \$8.50. This book contains a



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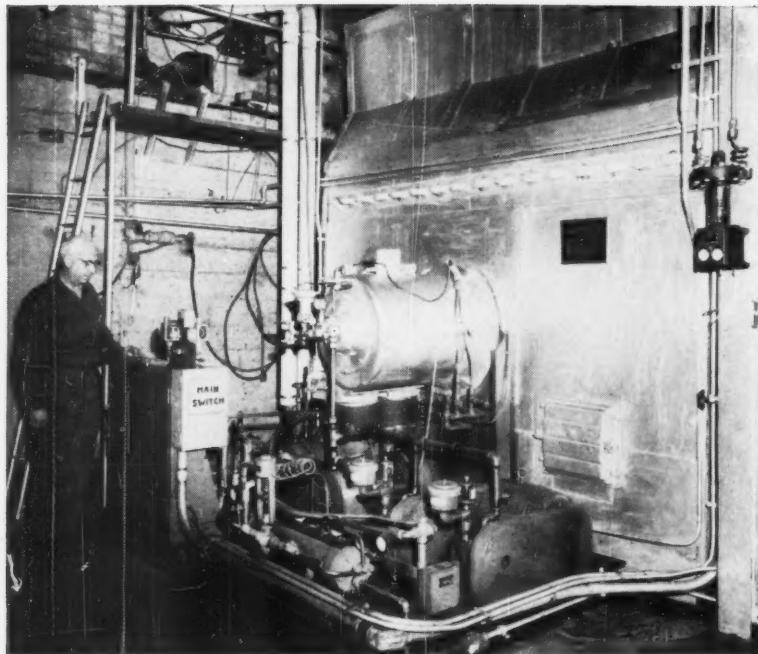
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listing of the characteristics and properties of metals, plastics, rubbers, paints, and cements. Stress is on corrosion-resistant qualities and fabrication methods.

THEORY OF THERMAL STRESSES, by Bruno A. Boley and Jerome H. Weiner; John Wiley & Sons, Inc., New York; \$15.50. This book covers all the current techniques for the determination of stresses produced in a solid object when it is heated. The topic is treated through four basic subjects: thermodynamics, heat transfer theory, elasticity, and inelasticity. There is also a review of heat transfer theory as a separate topic.

TRANSPORT PHENOMENA, by Bird, Stewart, and Lightfoot; John Wiley & Sons, Inc., New York; \$13.75. This book gives a parallel treatment of the three basic transport processes: flow of viscous fluids, flow of heat, and flow of chemical species in mixtures. Many of the topics are presented here for the first time in textbook form, including non-Newtonian fluid dynamics and dissipation heat effects.

ELECTRICAL DESIGN DETAILS, by Joseph McPartland and William Novak; McGraw-Hill, Inc., New York; \$8.50. Comprised largely of circuit diagrams and design sketches, this book illustrates the important features of wiring, circuit layout, equipment installation, and construction details. All the material is presented in conformity with the National Electric Code.

ANALOG AND DIGITAL COMPUTER TECHNOLOGY, by Norman R. Scott; McGraw-Hill Book Co., New York; \$12.75. Conceived as a text for use in advanced courses in electrical engineering, this book covers the principles of both analog and digital computers, stressing basic design and use data rather than recent improvements. The subject is treated from a practical rather than a theoretical viewpoint. □



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dry type transformers
save Transitron Electronic
\$5000 on installation costs



Our savings stem
from the lightweight,
compact size and special features
of Westinghouse
DT-3 Transformers

Growing rapidly since its founding in 1952, Transitron Electronic Corporation, now operating in three plants with a total footage of over 750,000 square feet, manufactures transistors, diodes, rectifiers, voltage regulators, controlled rectifiers and 4-layer switching devices. The modern distribution system serving Transitron's new plant—a renovated textile mill—includes 10 Westinghouse DT-3, 300-kva transformers. Plant Engineer H. R. Hammond (on cover) pinpoints how they saved Transitron over \$5000 on installation costs.

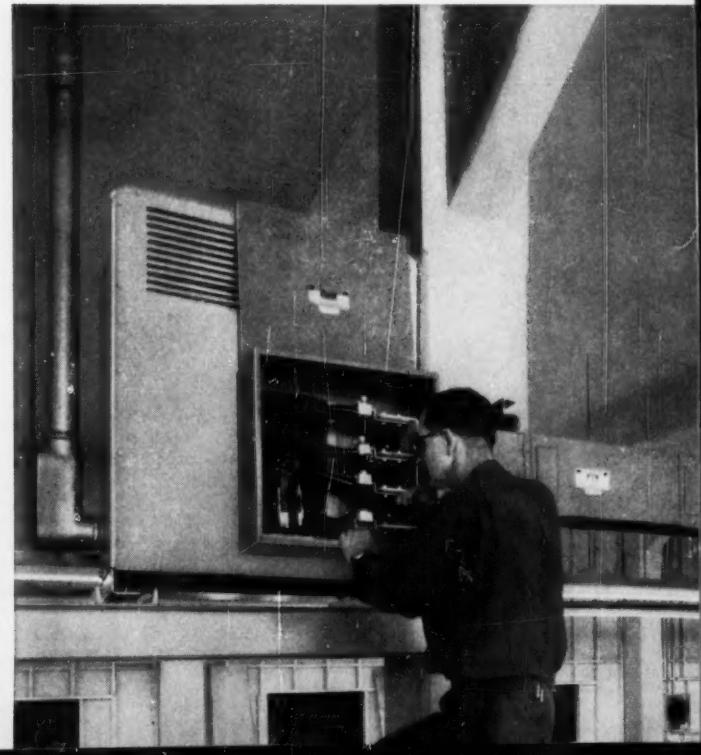
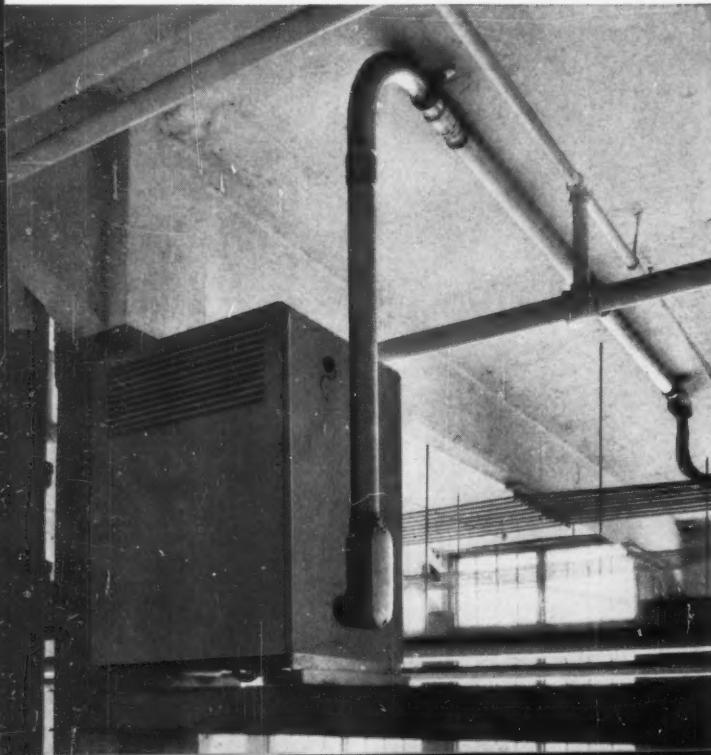
"Weighing only 1800 pounds each—about 40% less than a conventional unit—the DT-3's were mounted 10 feet off the floor on simple channel irons between building support columns.

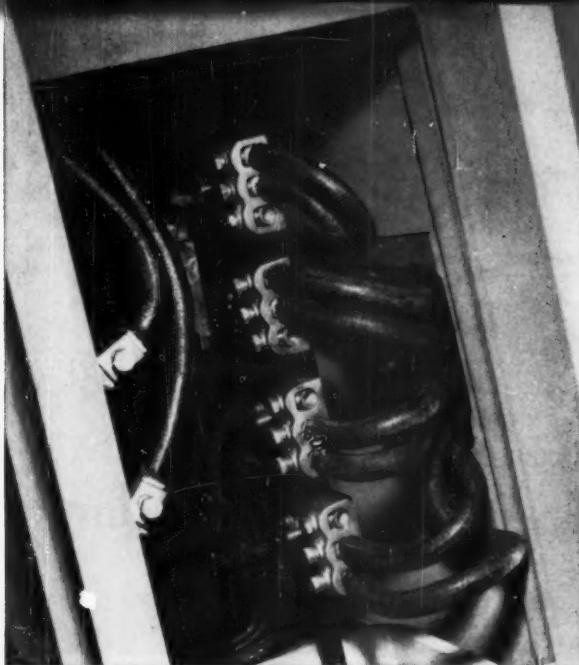
"At \$20 a square foot, this saved us \$1266 worth of floor space—not including an allowance for service area which would bring the saving to \$4000. Since reinforced structural supports were not needed, we saved \$40 on support material per unit.

"That's not all. The Westinghouse transformers were quickly positioned with a fork lift truck. Hoisting heavier types would have required rental of extensive rigging equipment, plus 16 man-hours apiece at \$68 per day.

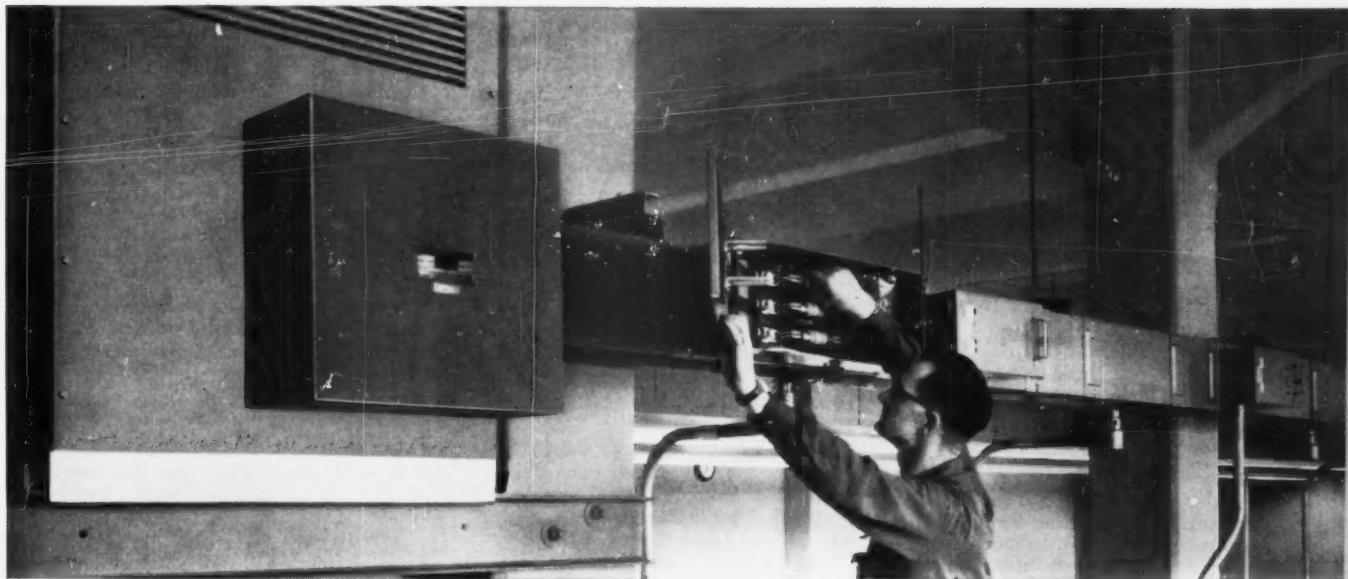
"Because of the transformer locations, 15 feet of 7-500,000 circular mill cable were eliminated. At \$150 for cable, \$50 for conduit and fittings, and \$34 for labor, we realized a saving of \$234 per transformer, or \$2340.

J-70951-2





"In addition, terminal compartments at the transformer bottom meant no extra insulation to withstand heat rise so we achieved a 60% saving. Since the transformers came with built-in shock mounts, we did not have to add them at an estimated total cost of \$320.



"Connected to the transformers is Westinghouse bus duct up to 70 feet long. Three lines leading through the duct deliver capacities of 1000 amps for production. The duct was easily tapped where necessary to put power where it's needed."

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Consulting Engineers' Calendar

Dec. 4-7. American Institute of Chemical Engineers; Annual Meeting, Statler Hotel, Washington, D. C.

Dec. 12-14. Public Health Service; National Conference on Water Pollution, Washington, D.C.

Dec. 12-15. Atomic Industrial Forum; Atomfair-West, Masonic Memorial Building, San Francisco, California.

Dec. 12-15. Industrial Building Congress, New York City Coliseum.

Dec. 12-15. American Nuclear Society; Winter Meeting, Mark Hopkins Hotel, San Francisco, California.

Dec. 14-16. Atomic Industrial Forum; Annual Conference, Fairmont Hotel, San Francisco, California.

Jan. 10-11. University of Wisconsin; Sanitary Engineering Institute, Campus, Madison, Wisconsin.

Jan. 16-18. The Pennsylvania State University; Conference for Land and Construction Surveyors, Campus, University Park, Pennsylvania.

Jan. 16-19. Instrument Society of America; Winter Instrument-Automation Conference & Exhibit, Sheraton-Jefferson Hotel and Kiel Auditorium, St. Louis, Missouri.

Jan. 18-20. American Road Builders' Association; Annual Convention, Cincinnati, Ohio.

Jan. 19. Engineers Joint Council; Annual Board Meeting, Biltmore Hotel, New York.

Jan. 23-Feb. 3. Cornell University; Short Course in Photointerpretation and Photogrammetry, Campus, Ithaca, New York.

Jan. 23-Feb. 3. University of California; 1961 Engineering and Management Course, Campus, Los Angeles, California.

Feb. 13-16. American Society of Heating, Refrigerating & Air-Conditioning Engineers; 15th International Heating, Refrigeration & Air-Conditioning Exposition, International Amphitheatre, Chicago, Illinois.

Feb. 19-23. American Society of Civil Engineers; Regional Convention, Texas Agricultural & Mechanical College, Houston, Texas.

Feb. 20-23. American Concrete Institute; 57th Annual Convention, Chase-Park Plaza Hotels, St. Louis, Missouri.

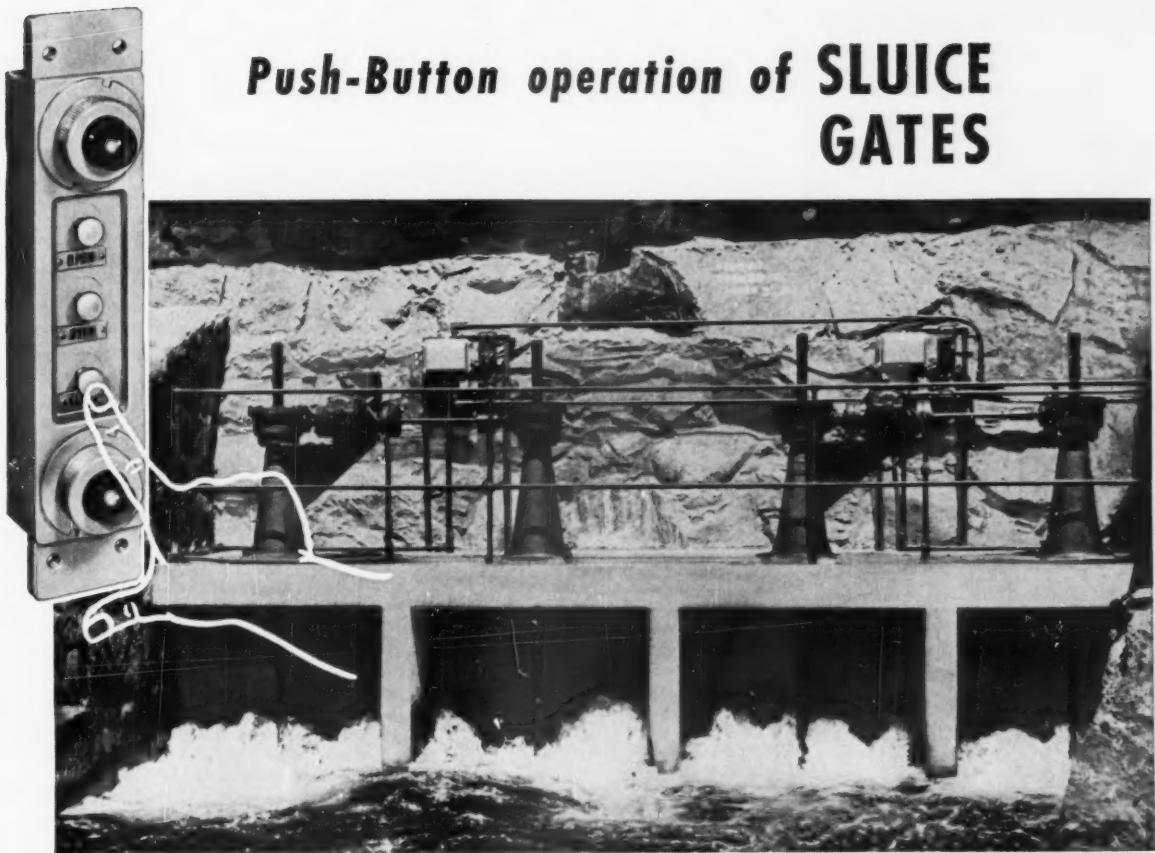
Feb. 26-March 1. American Institute of Chemical Engineers; National meeting, Roosevelt Hotel, New Orleans, Louisiana.

Feb. 26-March 2. American Institute of Mining Engineers; Annual Meeting, the Chase-Park Plaza Hotel and the Ambassador Hotel, St. Louis, Missouri.

March 5-8. American Road Builders' Association; Annual Convention, Haddon Hall, Atlantic City, N.J.

April 10-14. American Society of Civil Engineers; Convention, Hotel Westward Ho, Phoenix, Ariz. □

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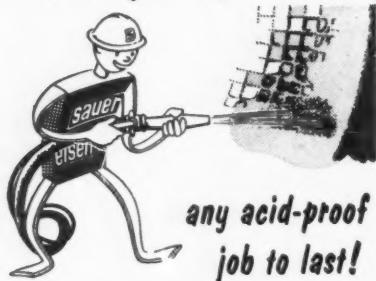
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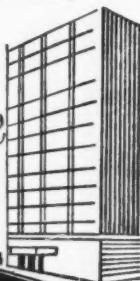
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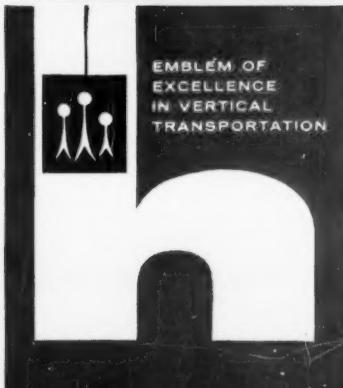
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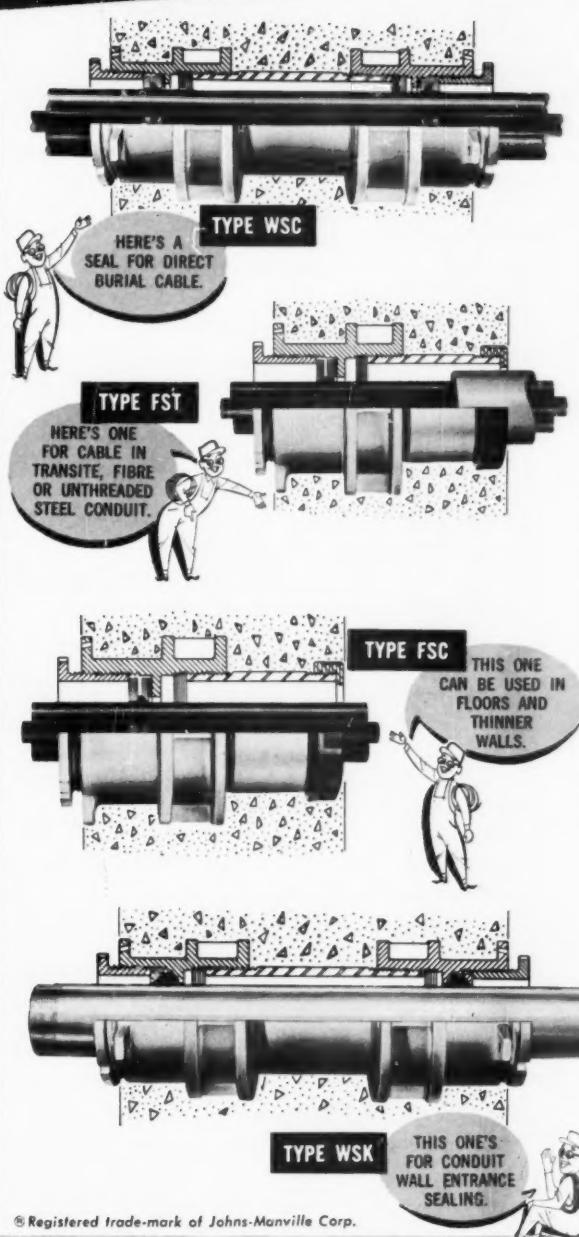
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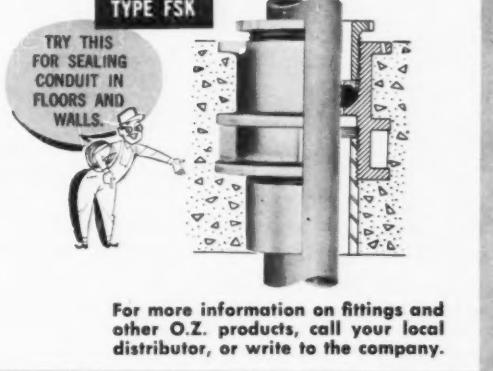
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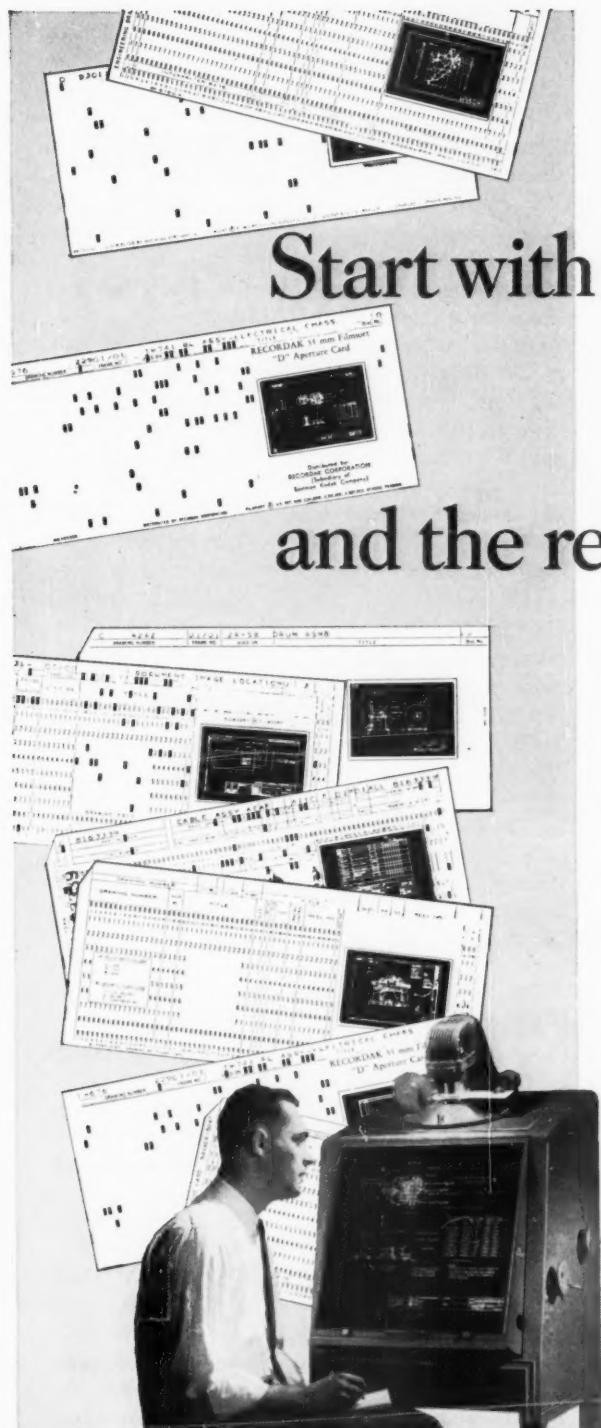
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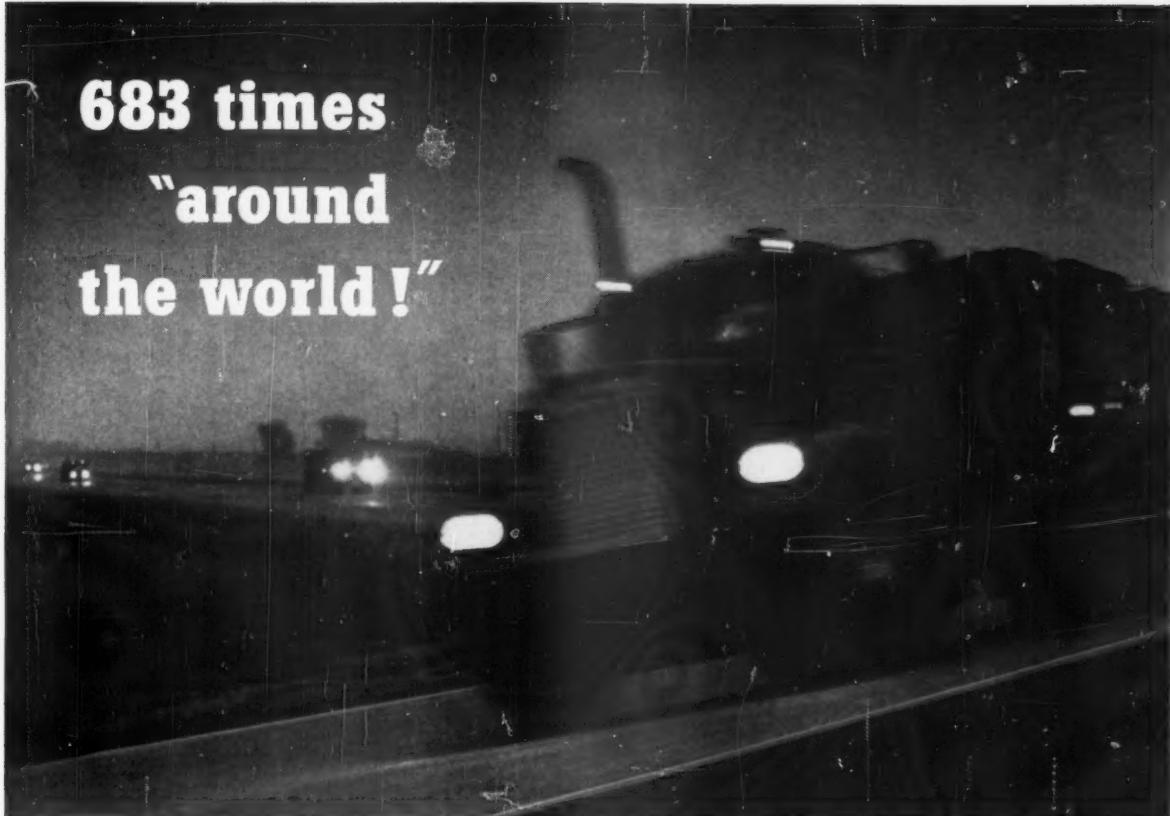
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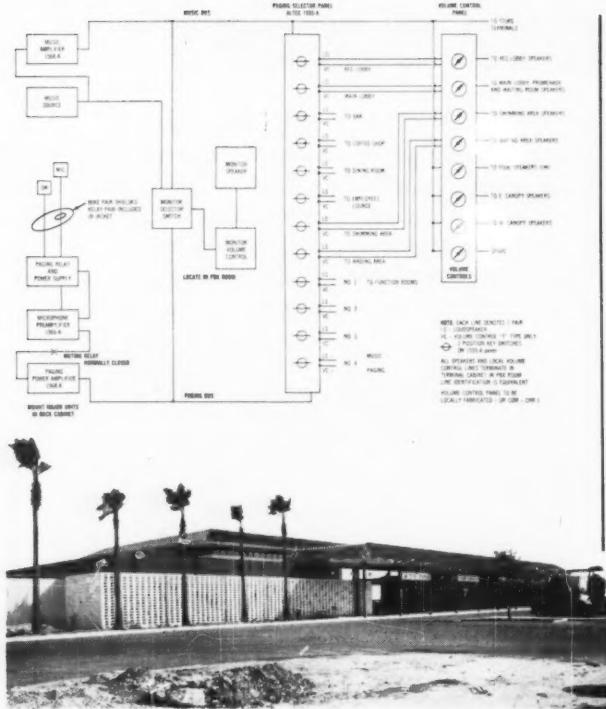
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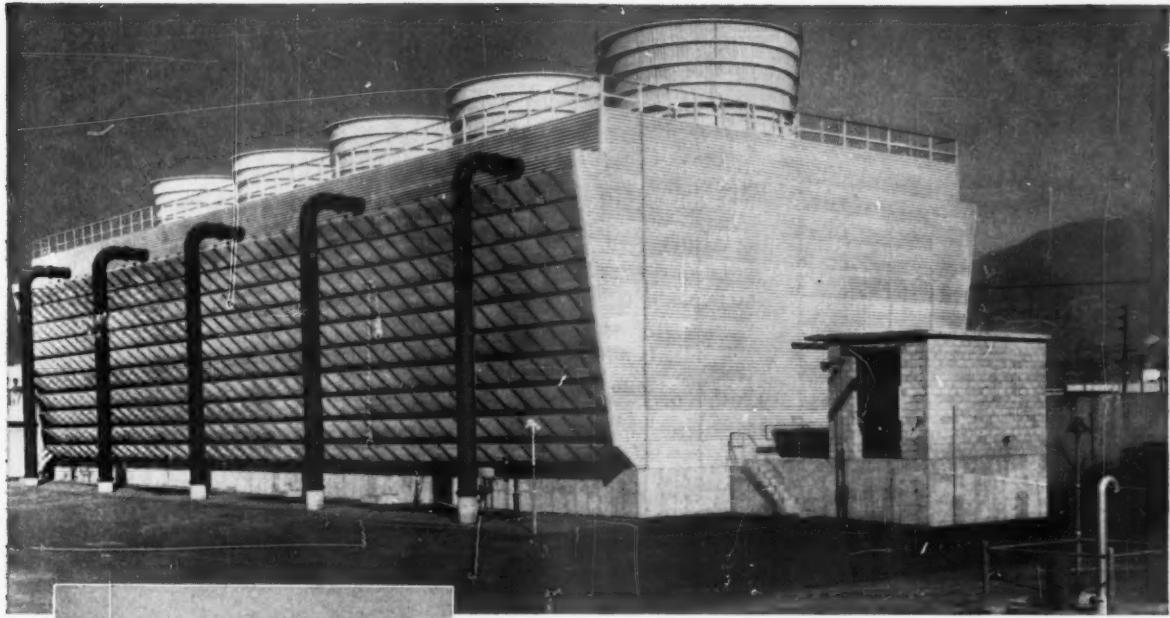
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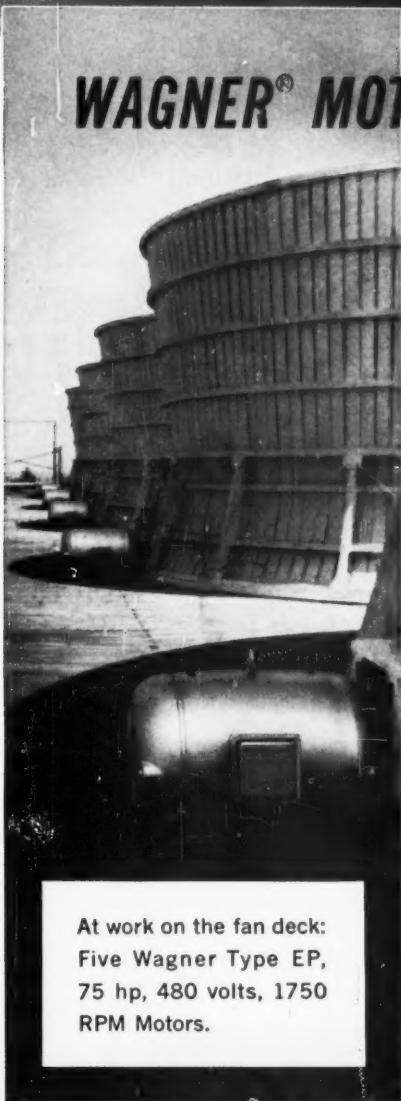
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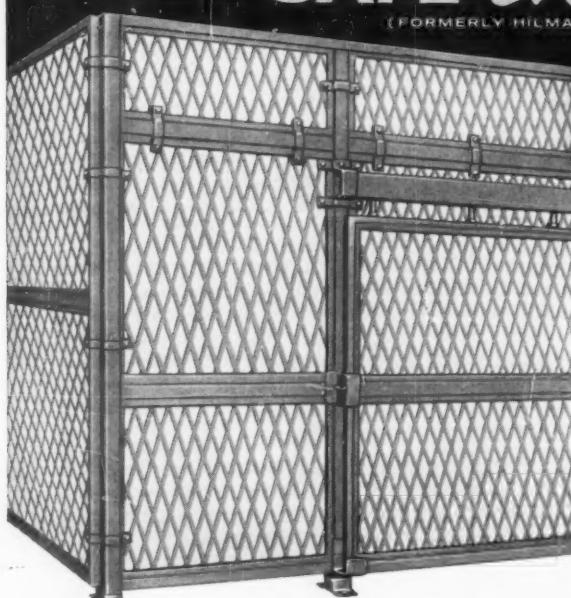
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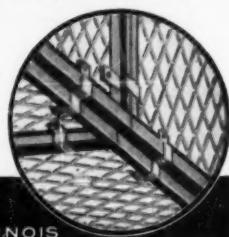
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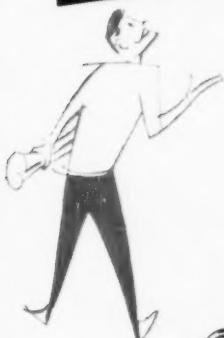


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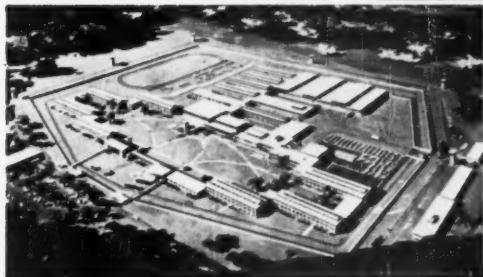
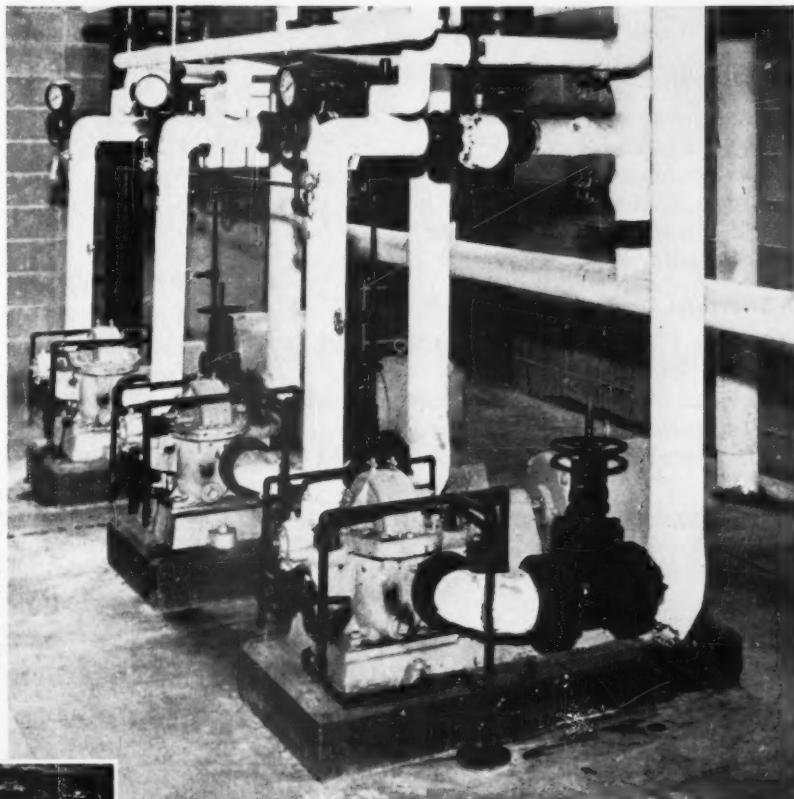
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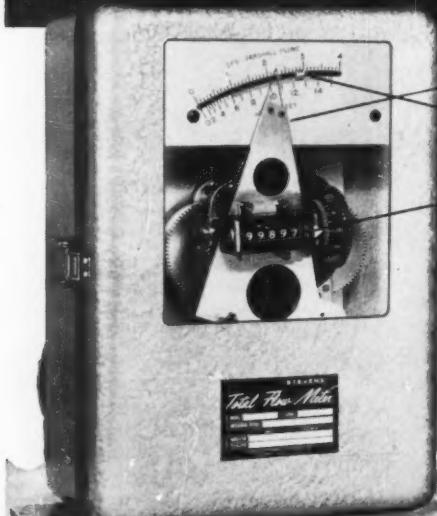
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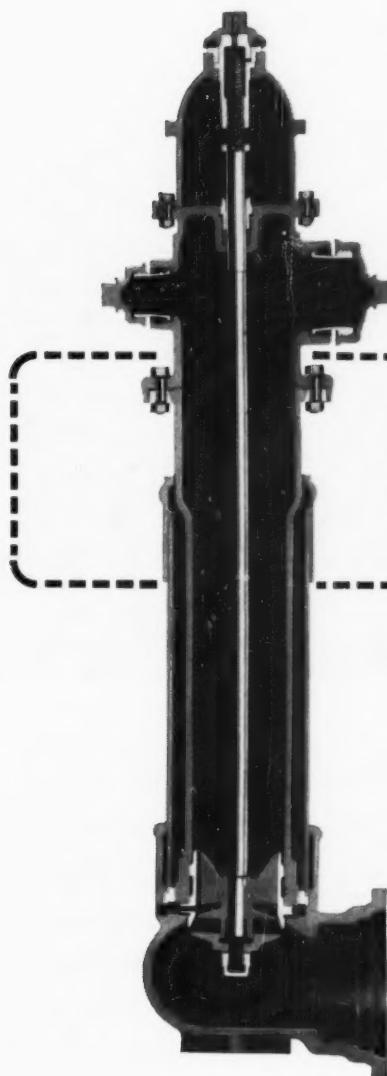
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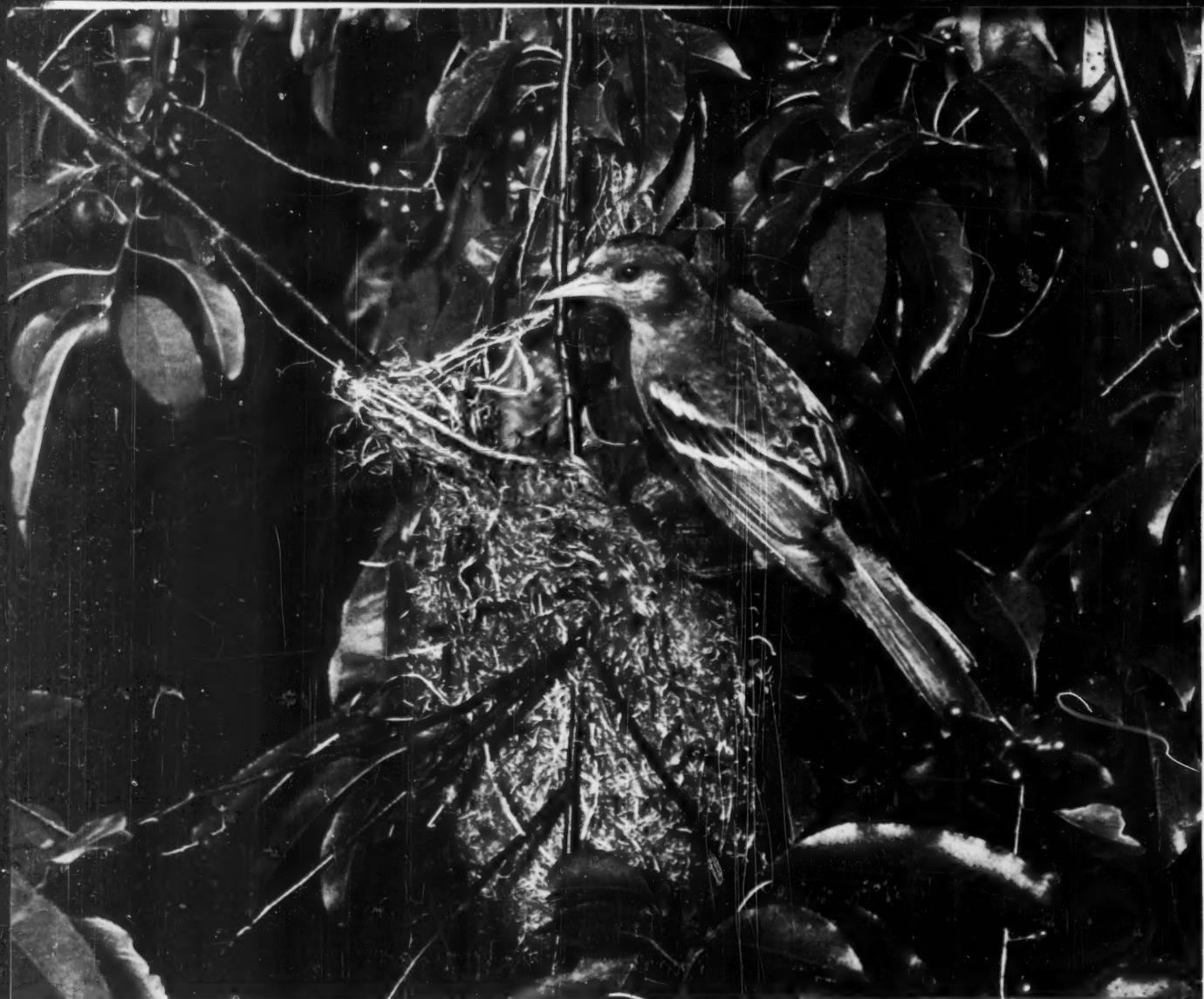
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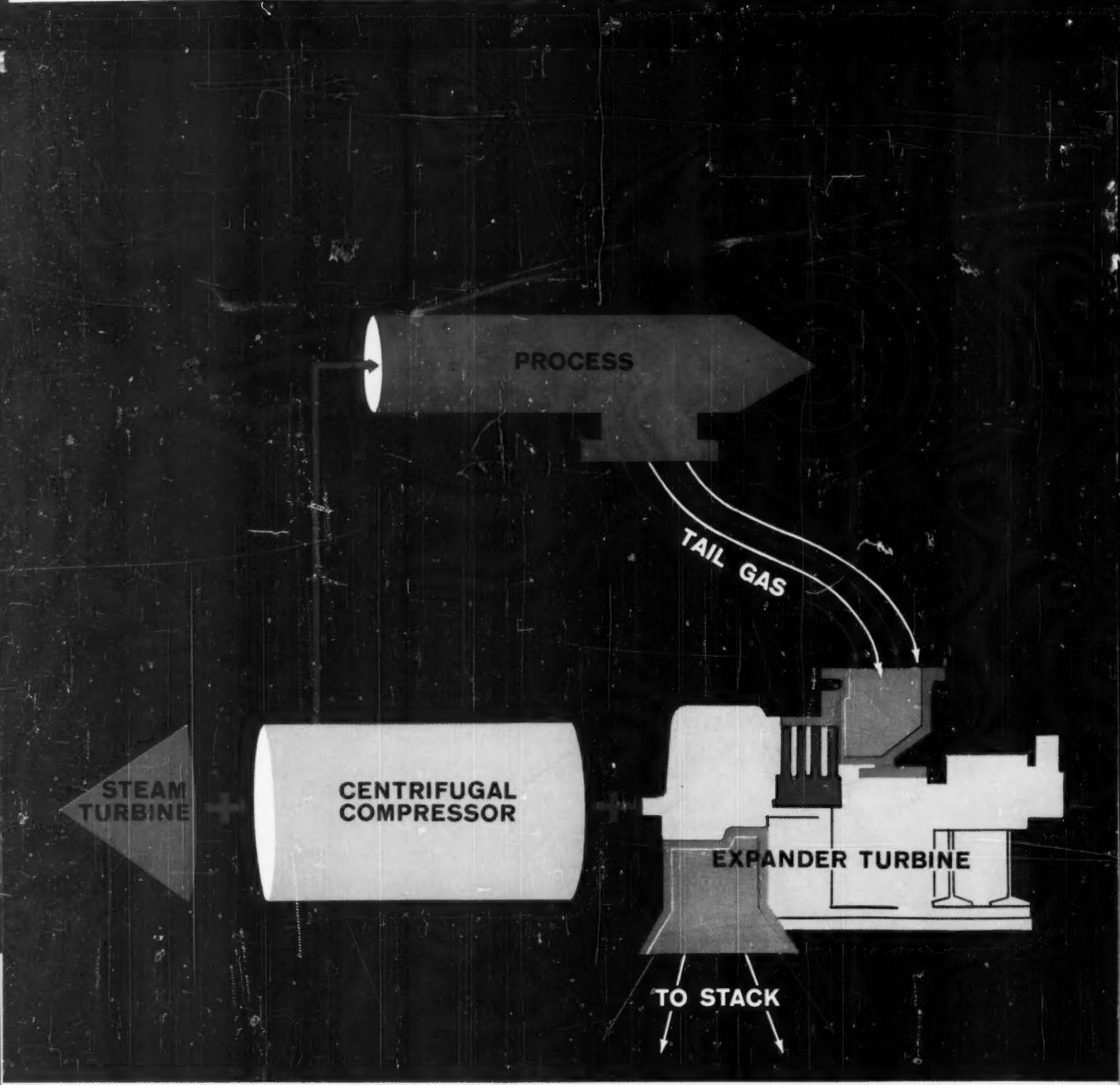
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